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CARIBBEAN ZOOPLANKTON. PART I. SIPHONOPHORA, HETEROPODA, COPEPO--ETC(U)
JUN 76 H B MICHEL, M FOYO, D A HAAGENSEN N00014-67-A-0201-0013

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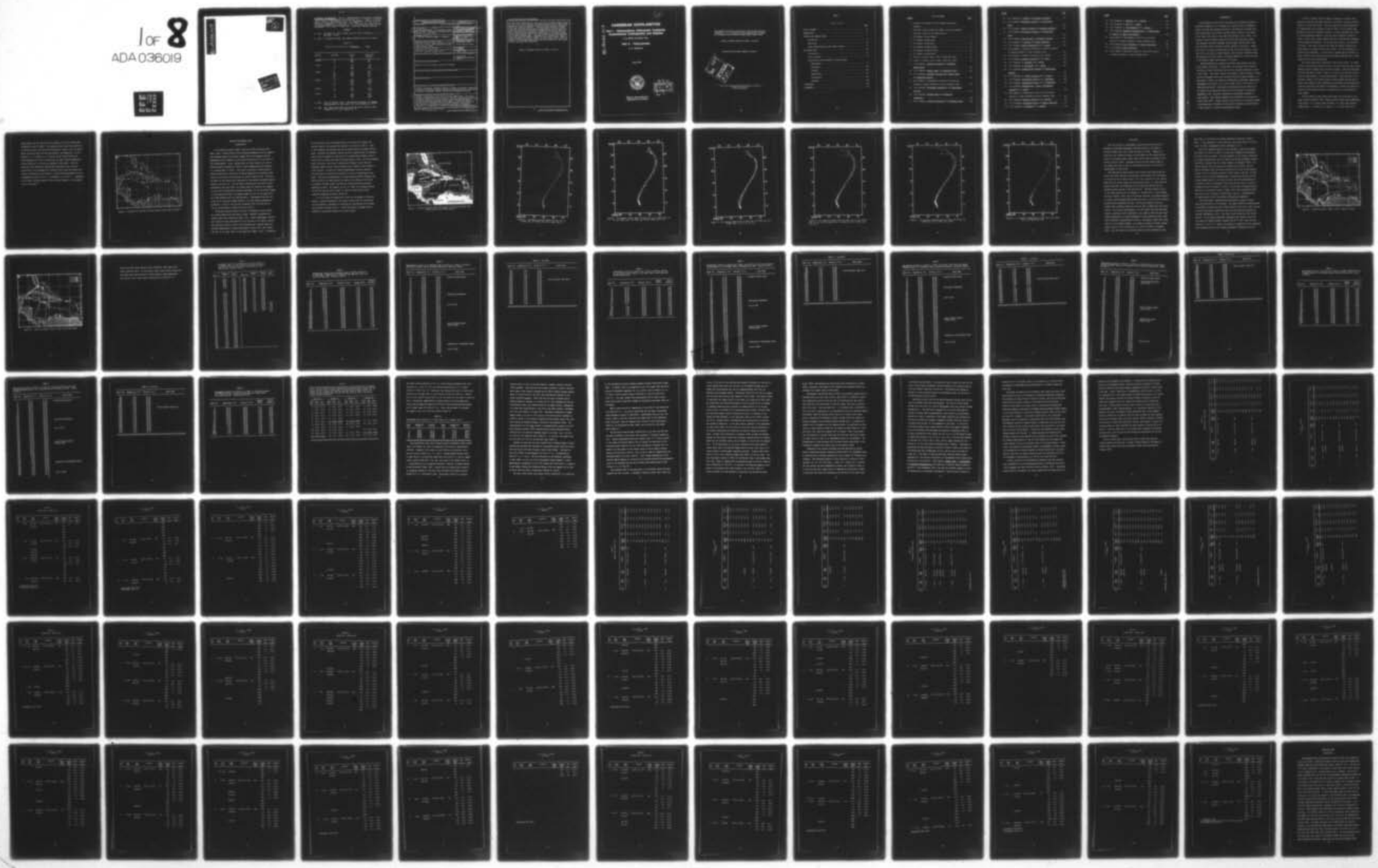

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B.S.

Caribbean Zooplankton. Part I, Siphonophora, Heteropoda, Copepoda, Euphausiacea, Chaetognatha and Salpidae, by H. B. Michel and Maria Foyo. Part II, Thecosomata, by D. A. Haagensen. Office of Naval Research, Department of the Navy, June 1976, 712 pp. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402 - Price $13. Stock No. 008-051-00066-6.

ERRATA

p. 101. In Table 24, add a sixth line of data: "Passages ... 4 ... 100-403 ...248.

p. 415. In Table 64, male and female symbols should be added:

TABLE 64

Vertical distribution of Euphausia [illegible]igibba

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	8	100	20♀
	12	300	25♀
P-6701	2	350	6♂♀
	5	90	50♂
	11	500	14♂♀
P-6803	15	400	10♂
	16	100	40♀
	18	480	10♀
	20	75	20♀
P-6811	3	500	20♂♀
	7	375	140♂♀
	11	590	25♀
	15	470	5♀
P-6904	11	524	10♀
	22	450	60♂♀
P-6911	2	53	50♂
	3	494	20♀
	8	510	60♂♀

p. 592. Line 14 should read, " He found the adults of conica concentrated in the upper 50 m and showing no ...."

p. 608. The figure reference in lines 26 and 27 should read "Figure 27 B", not "Figure 27 C".

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) CARIBBEAN ZOOPLANKTON. Part I. Siphonophora, Heteropoda, Copepoda, Euphausiacea, Chaetognatha ~~&~~ and Salpidae. Part II. Thecosomata.		5. ~~TYPE OF REPORT & PERIOD COVERED~~ (9) Final ~~on part of project~~ rept. April 1971-August 1976.
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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Plankton, Zooplankton, Caribbean zooplankton, Vertical distribution, Horizontal distribution, Upwelling, Indicator species, Caribbean water masses, Siphonophora, Heteropoda, Thecosomata, Copepoda, Euphausiacea, Chaetognatha, Salpidae.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Plankton and hydrographic data collected during ~~eight~~ 8 cruises in the oceanic Caribbean, adjacent waters, Florida Straits, and Gulf of Mexico were analyzed for species occurrence, relative abundance, ~~horizontal distribution~~ and horizontal and vertical distribution in relation to water masses. Plankton was sampled in horizontal tows of opening-closing 3/4 m nets at several levels between surface and bottom. All species of Siphonophora, Heteropoda, Thecosomata, Euphausiacea, Chaetognatha and Salpidae were identified and counted. Because

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over 400 pelagic copepod species occur in the area, 20 species common in major portions of the water column were individually counted and the remainder were enumerated as totals of calanoids, harpacticoids and cyclopoids, Cyclopoids almost equal calanoids numerically. Greatest numbers occurred in Tropical Surface Water and Subtropical Underwater, (upper 200 m), but many species are essentially restricted to Subantarctic Intermediate and North Atlantic Deep Water. Temperature-Salinity-Plankton diagrams clearly illustrate vertical distribution of species. Animals were most abundant in the central Caribbean and the Central American bight. Hydrographic and biological data showed upwelling off Venezuela, Colombia, Panama, Costa Rica and Nicaragua. Many reliable indicators of upwelling, coastal and oceanic waters, and possibly even movement of North Atlantic Central Water into the Caribbean were found among copepods, thecosomes and chaetognaths.

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CARIBBEAN ZOOPLANKTON

Part I - Siphonophora, Heteropoda, Copepoda, Euphausiacea, Chaetognatha and Salpidae

H. B. Michel and Maria Foyo

Part II - Thecosomata

D. A. Haagensen

June 1976

Office of Naval Research
Department of the Navy

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PART I

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INTRODUCTION

The background, objectives and procedures of an extensive program of zooplankton sampling in the Caribbean Sea, carried out by the Rosenstiel School of Marine and Atmospheric Science of the University of Miami from 1966 through 1969, have already been described as preface to the results of the first cruise (Owre & Low, 1969; Owre (Michel) & Foyo, 1972). The National Science Foundation supported the field and laboratory studies from September 1966 until September 1968 and again from May 1969 to May 1970 (GB-3808, GB-5776, GB-7082, GA-4569, GB-5625 and GB-13113). During the hiatus, the School provided funds so that work could continue. Since April 1971, the Office of Naval Research, under Contract N 0014-67-A-0201, has supported the entire project, including completion of laboratory work on 862 plankton samples and analyses of the data.

Because sampling was irregular and methods were tested on the first cruise (P6602, 29 January - 1 March 1966), the biological data differed from those of later collections and thus were presented separately by Owre & Foyo (1972). This report concerns the results of eight subsequent cruises, on which hydrographic data were collected along with plankton samples. In analyzing the latter, all species of Siphonophora, Heteropoda, Euphausiacea, Chaetognatha and Salpidea, and selected common species of Copepoda, were identified and counted. Additional contributions have been received or are expected from specialists working on the Thecosomata ("pteropods") (Haagensen, 1974), Ostracoda, Amphipoda and bathypelagic Copepoda in these samples. Many unusual organisms were encountered and one was described (Owre, 1973). Mainly, however, we have kept to our original purpose of providing basic information on the relative abundance and distribution of known species of important holoplanktonic groups.

In order to examine vertical ranges of organisms, horizontal tows, monitored by Benthos Time-Depth Recorders, were made at intervals from the surface to a depth near bottom. Nets were opened and closed mechanically at fishing depth, which extended as deep as 7500 m in the Brownson Deep. Mechanical failures occasionally occurred. The nets sometimes were fouled by large bathypelagic medusae or even torn away altogether, perhaps by sharks. Rarely, deep currents tangled the wire, preventing the messengers from actuating the mechanism. For the most part, however, the casts were successful. This report concerns only those 801 samples obtained from known depths on the eight cruises after P 6602. All were uniformly collected and are comparable. At each station, temperature and salinity, at least to 1500 m, were measured just before plankton sampling, and at some, oxygen and PO_4-P also were measured.

The cruise tracks were illustrated by Owre & Foyo (1972). To reduce clutter, the tracks were omitted in Fig. 1 and only those stations at which complete series of samples were obtained are marked. These are identified by cruise and number in Figs. 9 and 10. It can be seen that many were located in areas adjacent to the Caribbean proper. These stations, in the northwest Atlantic, the Florida Straits, Yucatan Channel and the Gulf of Mexico, were sampled to show differences in occurrence and distribution of tropical forms within and without the Caribbean, if these can possibly be sorted from the seasonal effects of reproduction and of alterations in water masses.

We are indebted to many persons who helped with field work on the eight cruises following P 6602: Manuel Aparicio, Elaine Bunce (NAVOCEANO), Irene Cooper, C. N. D'Asaro, Nancy Gebelien, A. E. Hine, Jake Lathrop, Barbara Mayo, J. F. Michel, M. R. Reeve, E. J. F. Wood, Gabriel and

Sandra Vargo, and the officers and crew members of the R/V JOHN ELLIOTT PILLSBURY and the R/V GERDA. The program could not have been carried out successfully without the skill and enthusiasm of James K. Low, the Senior Marine Technician when this work was going on, now Supervisor. We are grateful to J. F. Michel, E. F. Corcoran, Jeanne Cruise Stepien and Donald Haagensen for aid of various kinds and many valuable suggestions during evaluation of the data and assembly of the report. Both Mrs. Paula Diaz, who handled the computerized hydrological data, and Mrs. Yvonne Milton, who programmed the biological data, were very helpful and patient in dealing with our requests. We particularly appreciate the encouragement and advice of Dr. C. D. Woodhouse, Jr. and Mr. B. J. Zahuranec, of the Oceanic Biology Program, Office of Naval Research, in the preparation of this report.

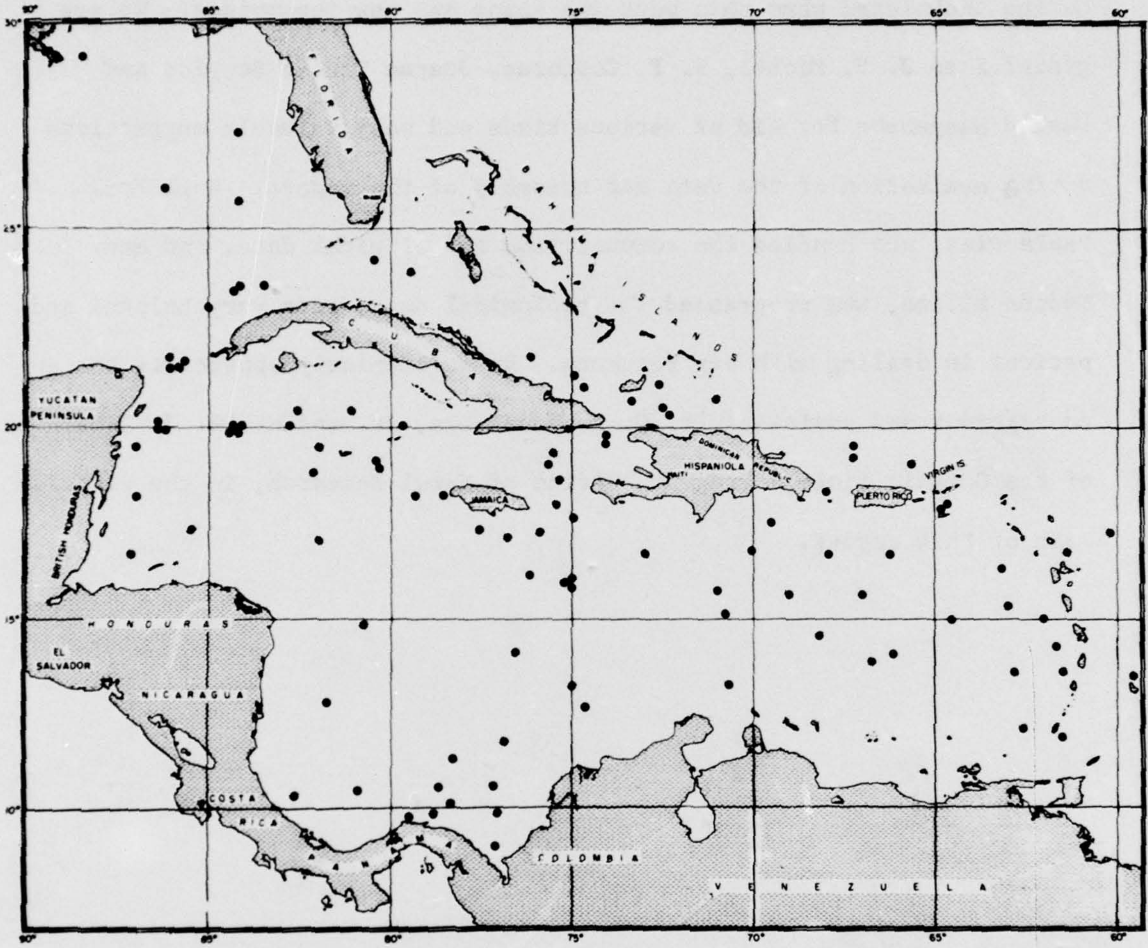

Figure 1. Locations of stations at which complete series were collected

PHYSICAL AND CHEMICAL DATA

Introduction

On the earlier cruises P 6606, G 6722 and P 6803, hydrocasts were made, using 5 l Niskin bottles with reversing thermometers, and the samples were analyzed ashore for salinity, oxygen (ml/l) and phosphate (PO_4-P). Measurements were obtained at levels which coincided with or were close to the fishing depths. Later, lacking funds for water chemistry, we used a Bissett-Berman STD (Model No. 9006) to record temperatures and salinities to a maximum depth of 1500 m. Data from all stations at which series of plankton samples were collected, including temperature and available chemistry at the various fishing depths, are found in Tables 13-20. The fishing depth is the average depth registered by the Benthos Time-Depth Recorder during a hour-long tow. As this rarely coincided with the depth at which hydrographic data were taken, the figures given for chemistry and temperature are often interpolations between measurements at the two nearest depths. In interpolating STD data, the maximum ranges are 12 m in the upper 200 m, 24 m from 200-600 m and 30 m from 600-1500 m. Hydrographic data were collected at all stations occupied whether or not the plankton sampling was successful, a total of 181 stations including P 6602, and these are on file at the University of Miami as well as N.O.D.C.

Using data selected from all cruises, T/S diagrams of waters within the Yucatan Channel and the Yucatan, Cayman, Colombian, Venezuelan and Grenada Basins were constructed (Figs. 3-8). Certain hydrographic profiles were selected to show some details of the structure in the basins, preferably pairing an earlier profile, which extended over a greater range and included measurements of oxygen and phosphate levels, with a more recent STD trace of the upper 1500 m in the same area (Tables 2-10). In addition,

all data obtained from the Brownson Deep of the Puerto Rico Trench, the greatest depth in the western North Atlantic, are given in Table 1. Within the Caribbean, the Bartlett Deep in the Cayman Trench was sampled several times. Profiles from adjacent stations provide comparison with the Brownson Deep as well as examples of structure in the Cayman Basin (Tables 2 and 3). Tables 4 and 5 contain data from the Yucatan Basin; 6 and 7, from the Colombian Basin, the latter in an area of upwelling off Panama; 8 and 9 from the Venezuelan Basin; and 10, from the eastern Gulf of Mexico, near Pequenat's (1972) station. In Table 11, selected measurements from four stations off the coasts of Venezuela and Colombia in an area of upwelling are compared. The bottom soundings given in these tables may differ somewhat from those stated for the same stations in Tables 13-20, owing to drift while on station, although usually the ship was repositioned before plankton sampling was begun. For example, at Sta. 6, P 6904, the sounding recorded for the STD cast was 5319 m (Table 3), while the depth when plankton towing was commenced was 6600 m (Table 19).

It is not within our capability to treat the hydrography of the area. However, a general knowledge of the sources of water and the circulation in the Caribbean is important in evaluating the distribution of the planktonic animals collected from it. A brief discussion of present data in relation to some recent studies in the area follows.

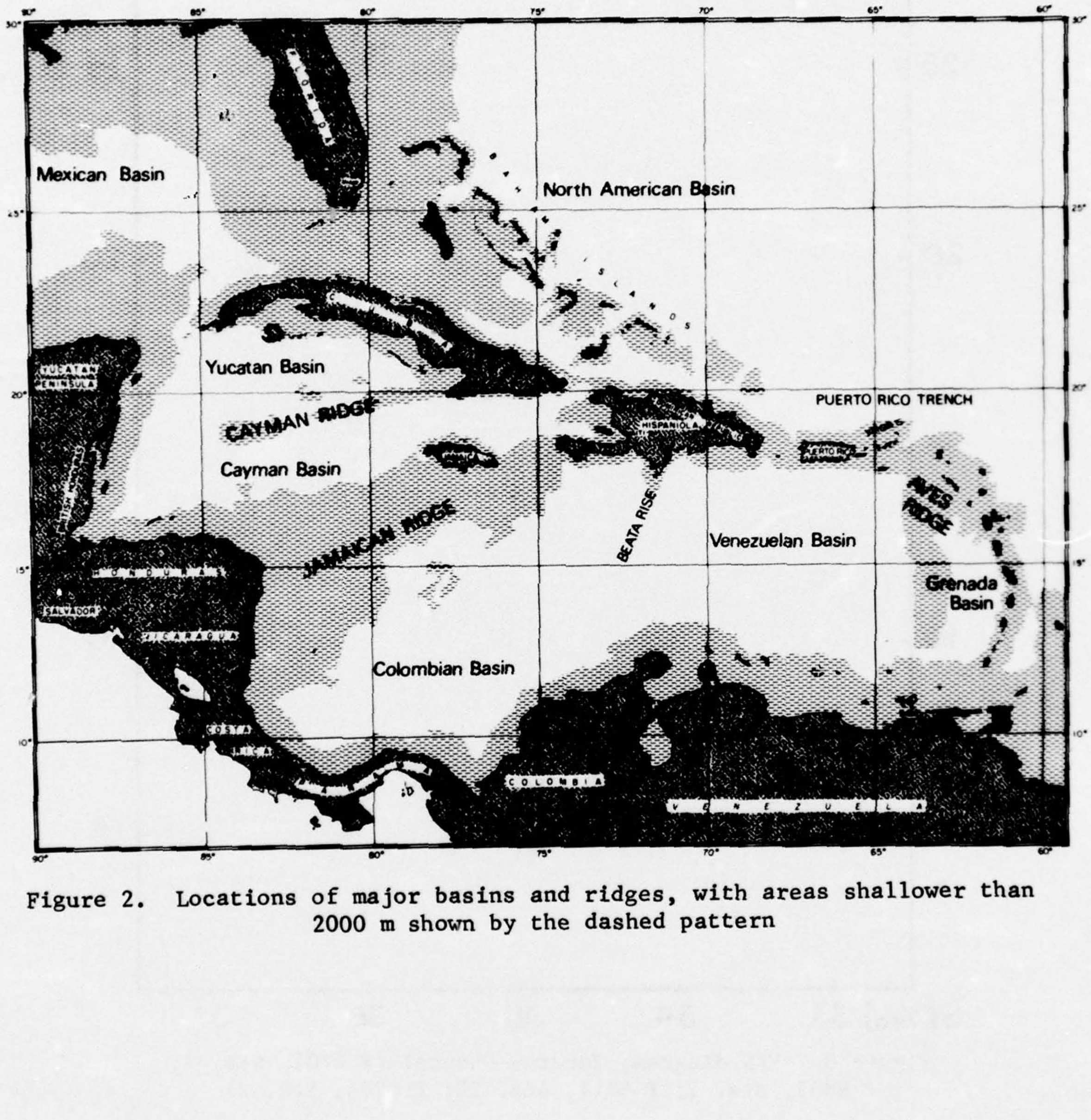

Figure 2. Locations of major basins and ridges, with areas shallower than 2000 m shown by the dashed pattern

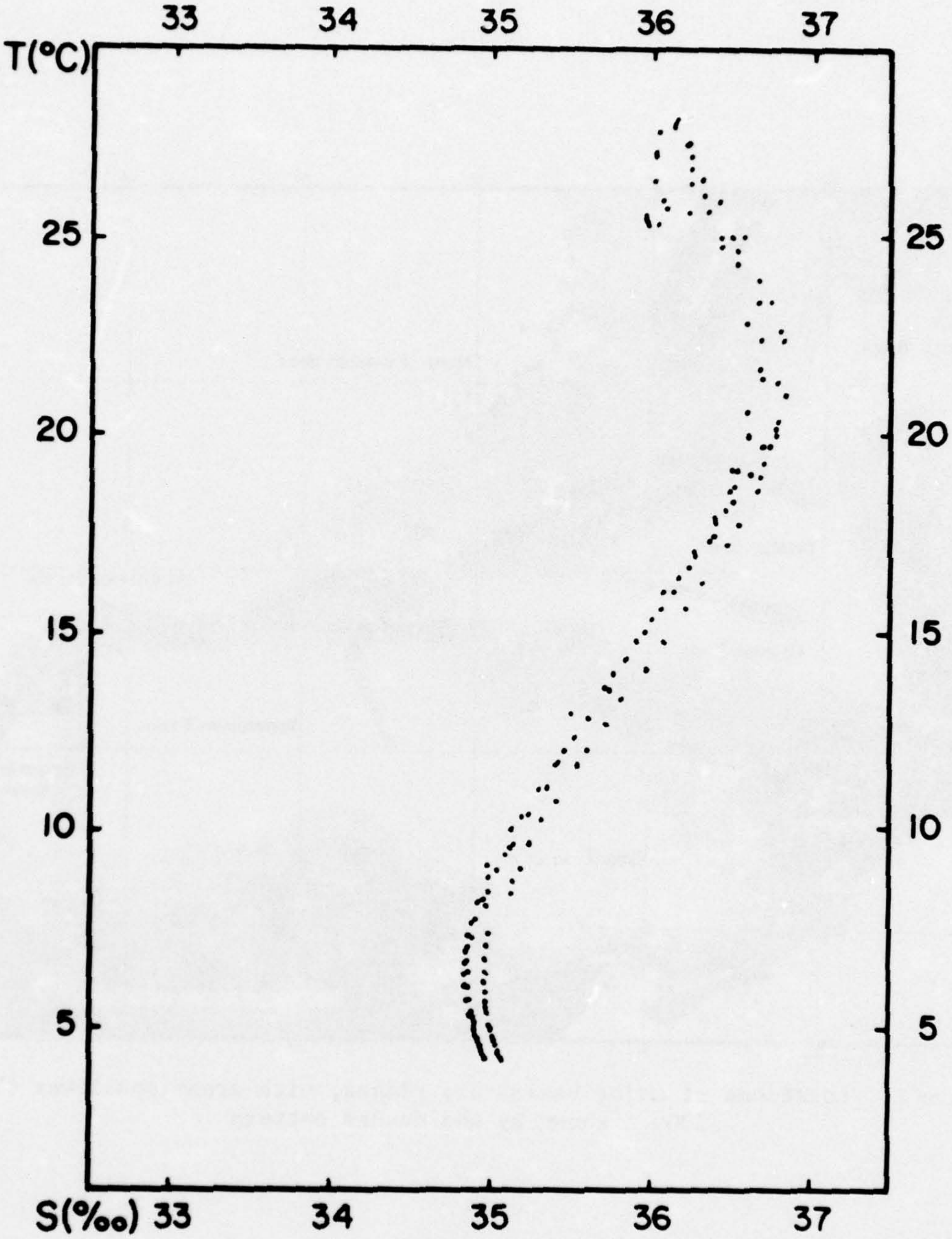

Figure 3. T/S diagram, Yucatan Channel (P 6701, Sta. 2; P 6805, Sta. 2; P 6811, Sta. 20; P 6904, Sta. 2)

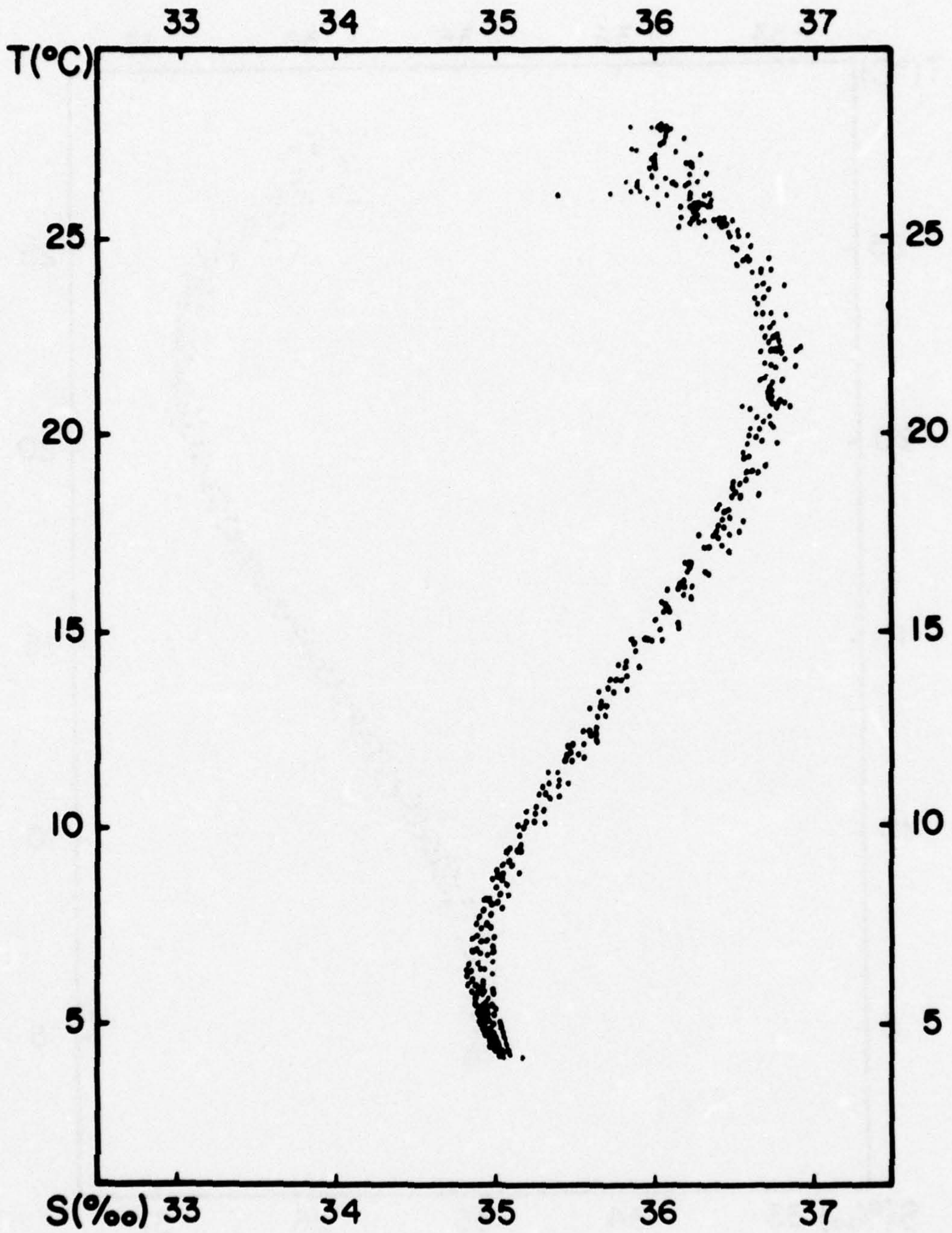

Figure 4. T/S diagram, Yucatan Basin (P 6701, Sta. 4, 5; P 6803, Sta. 16, 17, 22; P 6805, Sta. 3; P 6811, Sta. 15-19; P 6904, Sta. 3, 4)

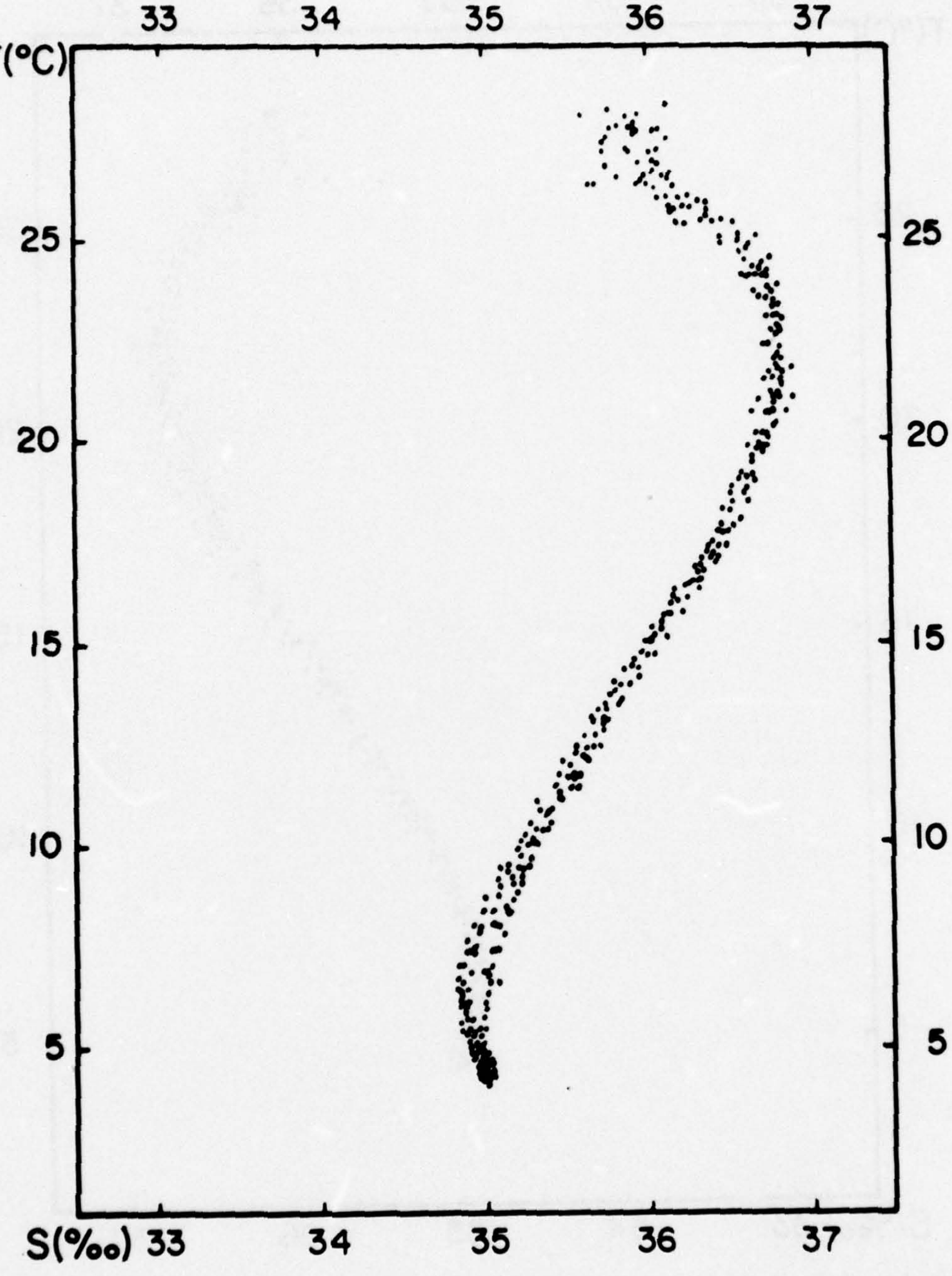

Figure 5. T/S diagram, Cayman Basin (P 6701, Sta. 8; P 6803, Sta. 18; P 6904, Sta. 5, 6, 7, 12, 13, 14)

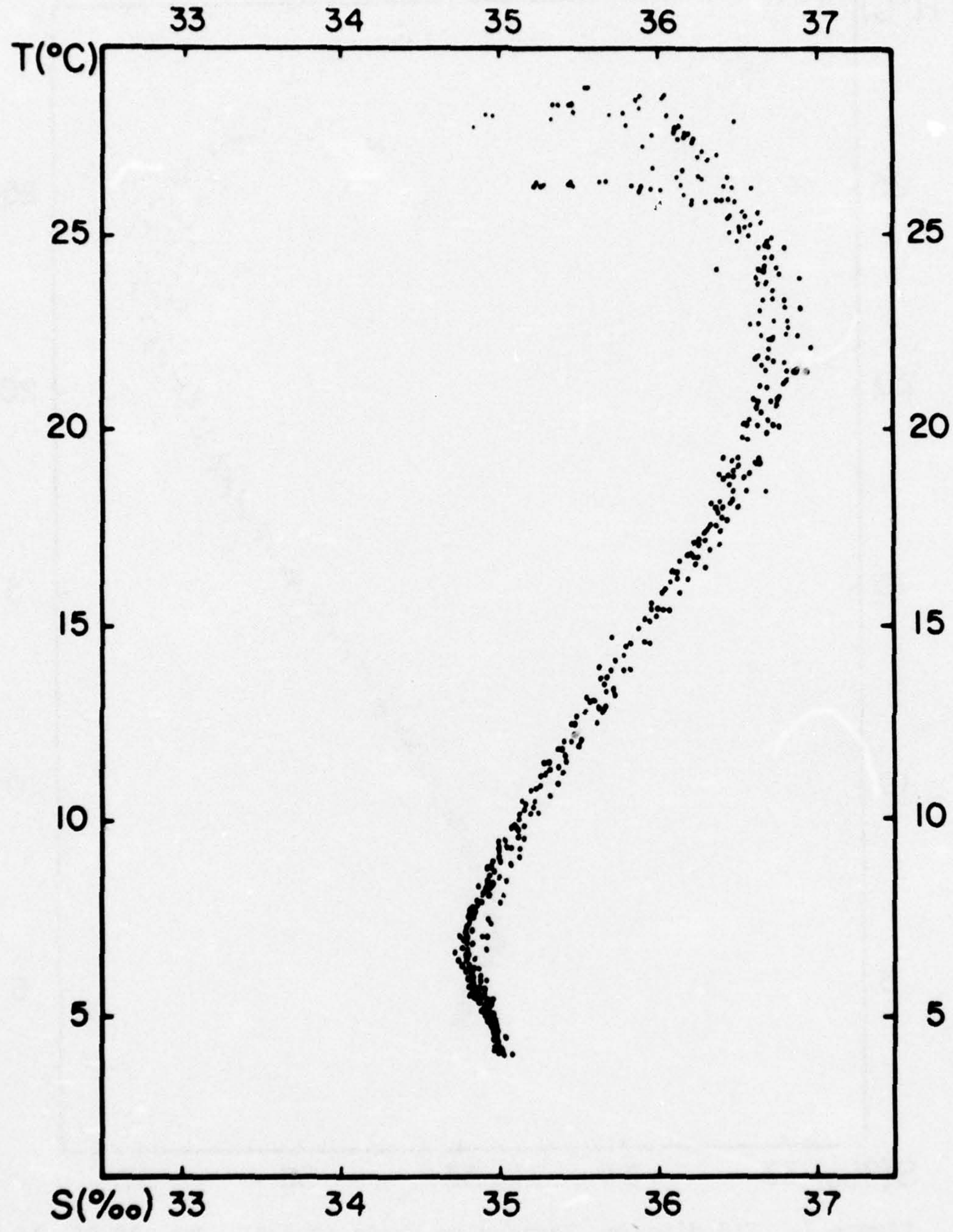

Figure 6. T/S diagram, Colombian Basin (P 6606, Sta. 8, 11; P 6701, Sta. 10, 11, 22, 24; P 6805, Sta. 7; P 6904, Sta. 10; P 6811, Sta. 3-6, 8, 9)

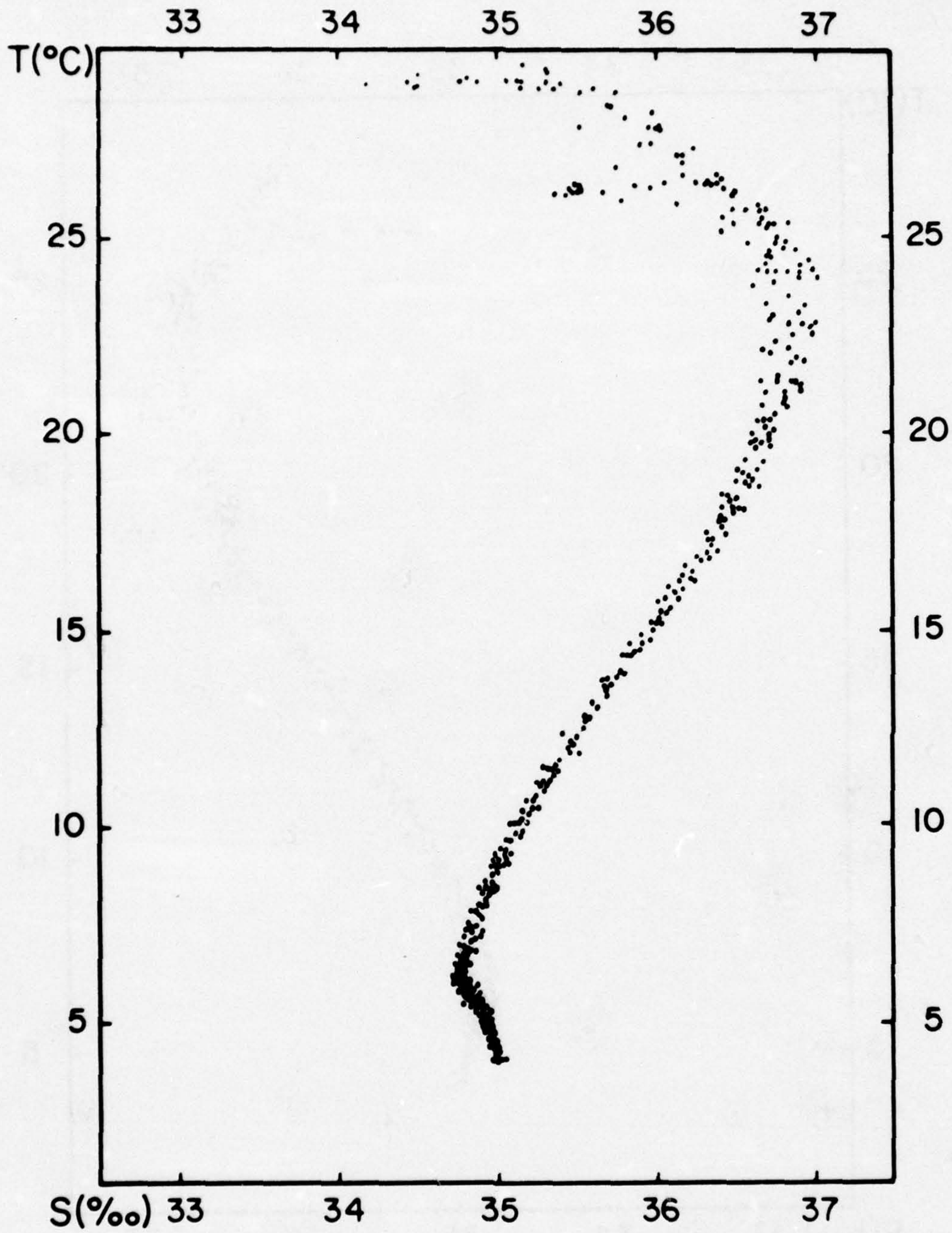

Figure 7. T/S diagram, Venezuelan Basin (P 6701, Sta. 12-14, 18; P 6805, Sta. 9-11; P 6911, Sta. 7-11)

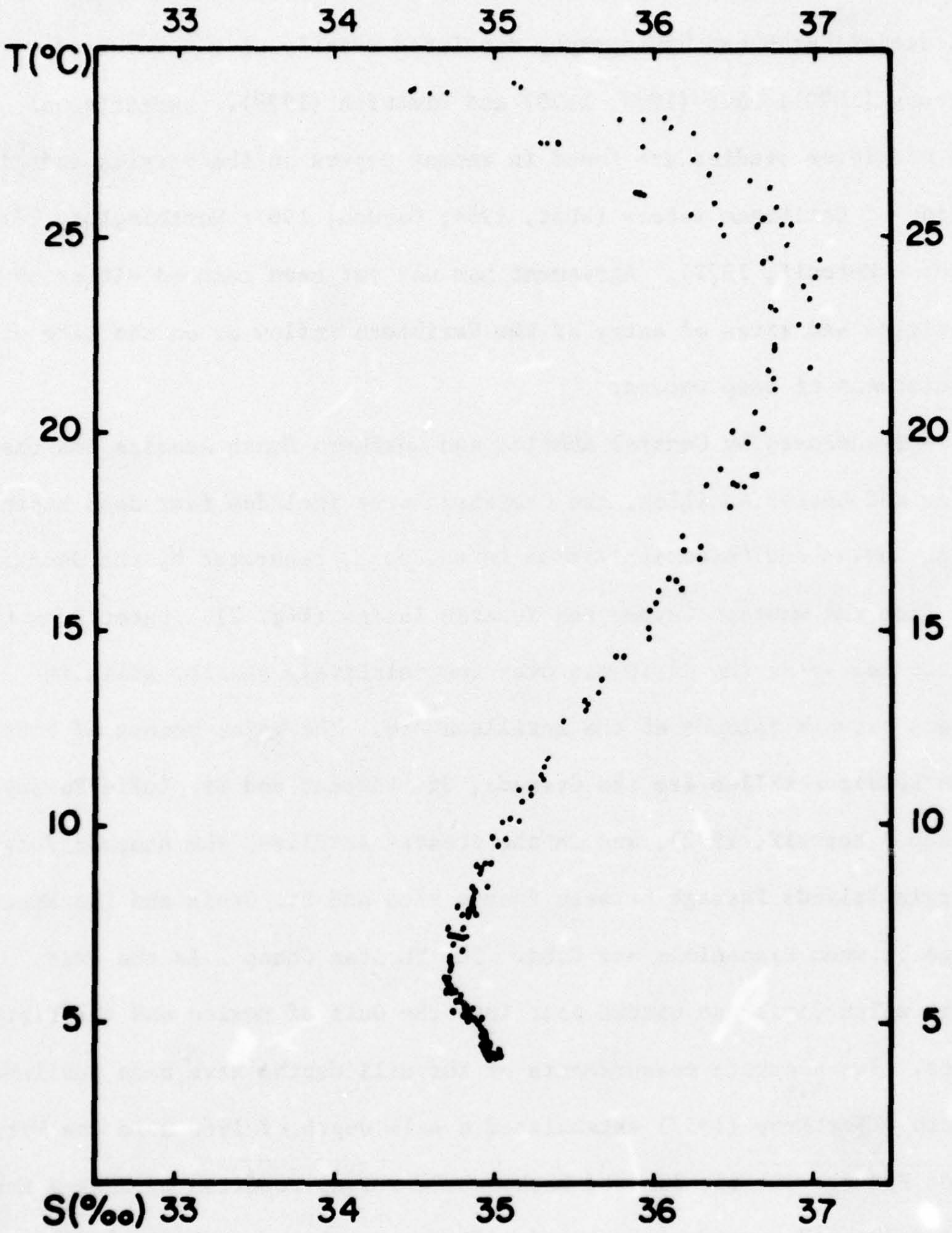

Figure 8. T/S diagram, Grenada Basin (P 6701, Sta. 16; G 6722, Sta. 17; P 6911, Sta. 3-5)

Discussion

Until the revival of oceanographic exploration after World War II, knowledge of Caribbean hydrography consisted chiefly of the works of Pillsbury (1890), Parr (1937, 1938) and Dietrich (1939). Summaries of these and later studies are found in recent papers on the origins and circulation of Caribbean waters (Wüst, 1964; Gordon, 1967; Worthington, 1971; Stalcup & Metcalf, 1972). Agreement has not yet been reached either on the origins and sites of entry of the Caribbean inflow or on the rate of replenishment of deep waters.

Semi-enclosed by Central America and northern South America and the Greater and Lesser Antilles, the Caribbean area includes four deep basins, the Venezuelan and Colombian Basins to the east, separated by the Jamaican Ridge from the western Cayman and Yucatan Basins (Fig. 2). Water from the Atlantic may enter the Caribbean over the relatively shallow sills in passages between islands of the Antillean Arc. The major points of entry in the Lesser Antilles are the Grenada, St. Vincent and St. Lucia Passages (Stalcup & Metcalf, 1972), and in the Greater Antilles, the Anegada/Jungfern or Virgin Islands Passage between Puerto Rico and St. Croix and the Windward Passage between Hispaniola and Cuba. The Yucatan Channel is the exit through which Caribbean waters pour into the Gulf of Mexico and the Florida Straits. Few accurate measurements of the sill depths have been published. Frasetto & Northrup (1957) established a sill depth of 1960 m in the Virgin Islands Passage but the limited bathymetric survey reported by Ross & Mann (1971) indicated a maximum depth of 1870 m. Worthington (1966, 1971) found 1540 m for the Windward Passage. Our transect through the Grenada Passage showed a sill at 752 m (G 6722, Sta. 16, 11°41'N, 62°08'W, 11 December 1967). The sill depth of the Yucatan Channel has been estimated at less

than 1900 m, on the basis of potential temperature (McLellan & Nowlin, 1963). A 1961 bathymetric survey showed the controlling depth to be 2013 m (Chart BC 0904N, Oceanographic Office, Washington, D.C.).

Within the framework imposed by ship schedules, cooperative programs and weather, an effort was made to collect data throughout the Caribbean in both wet and dry seasons. The areas sampled on four cruises during the wet season (June-November) were the western and central Caribbean (P 6606), the central Caribbean from the Yucatan Channel to Trinidad (P 6805), the Central American Gyre and central and western areas (P 6811), and the eastern Caribbean within the Lesser Antillean Arc as well as the Antilles Current north of the Greater Antilles (P 6911) (Figs. 9 and 10). On four cruises in the dry season (December-May), stations were located from the Yucatan Channel nearly to the Lesser Antilles and then westsouthwesterly to Panama (P 6701), in passages of the Lesser Antilles from St. Croix to Grenada and also off Barbados (G 6722), in the central and western Caribbean and in the Antilles Current (P 6904), and in the northwestern Caribbean and the Gulf of Mexico (P 6803) (Figs. 9 and 10). Characteristics of surface waters reflect the climatic differences as expected.

Four water masses, separated from one another by zones of mixing, have been identified in the Caribbean. The upper 50-100 m are characterized by relatively low-salinity water termed Tropical Surface Water (TSW), derived from the intertropical convergence zone where precipitation exceeds evaporation (Worthington, 1971). This layer can be traced into the Florida Straits. In the eastern Caribbean, temperature and salinity of the surface layer are highly variable, ranging from 22° to >28° C and from less than 33 ‰ to 37 ‰, owing to the effects of upwelling off the Venezuelan and Colombian coasts and the seasonal discharge of freshwater from the

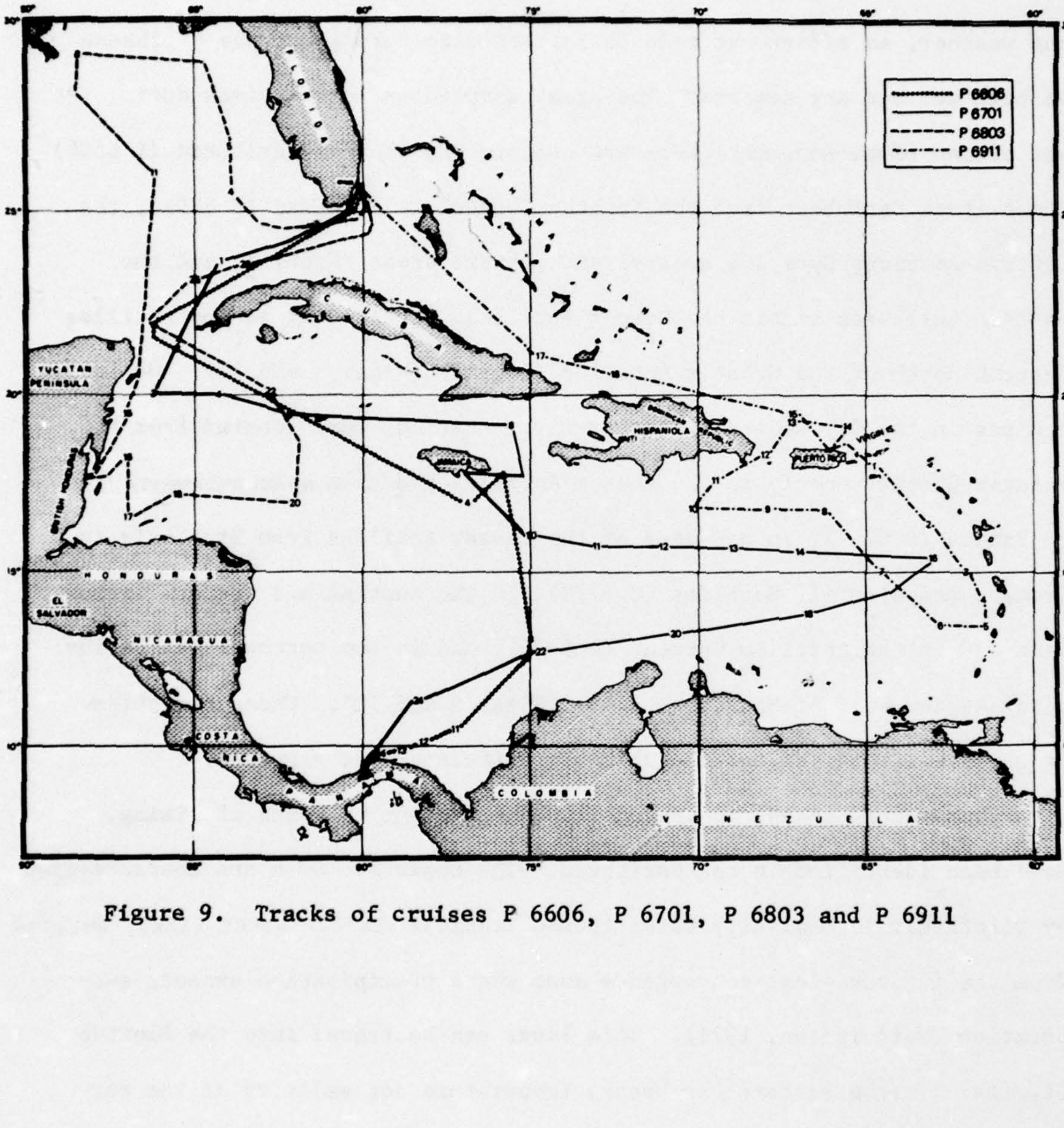

Figure 9. Tracks of cruises P 6606, P 6701, P 6803 and P 6911

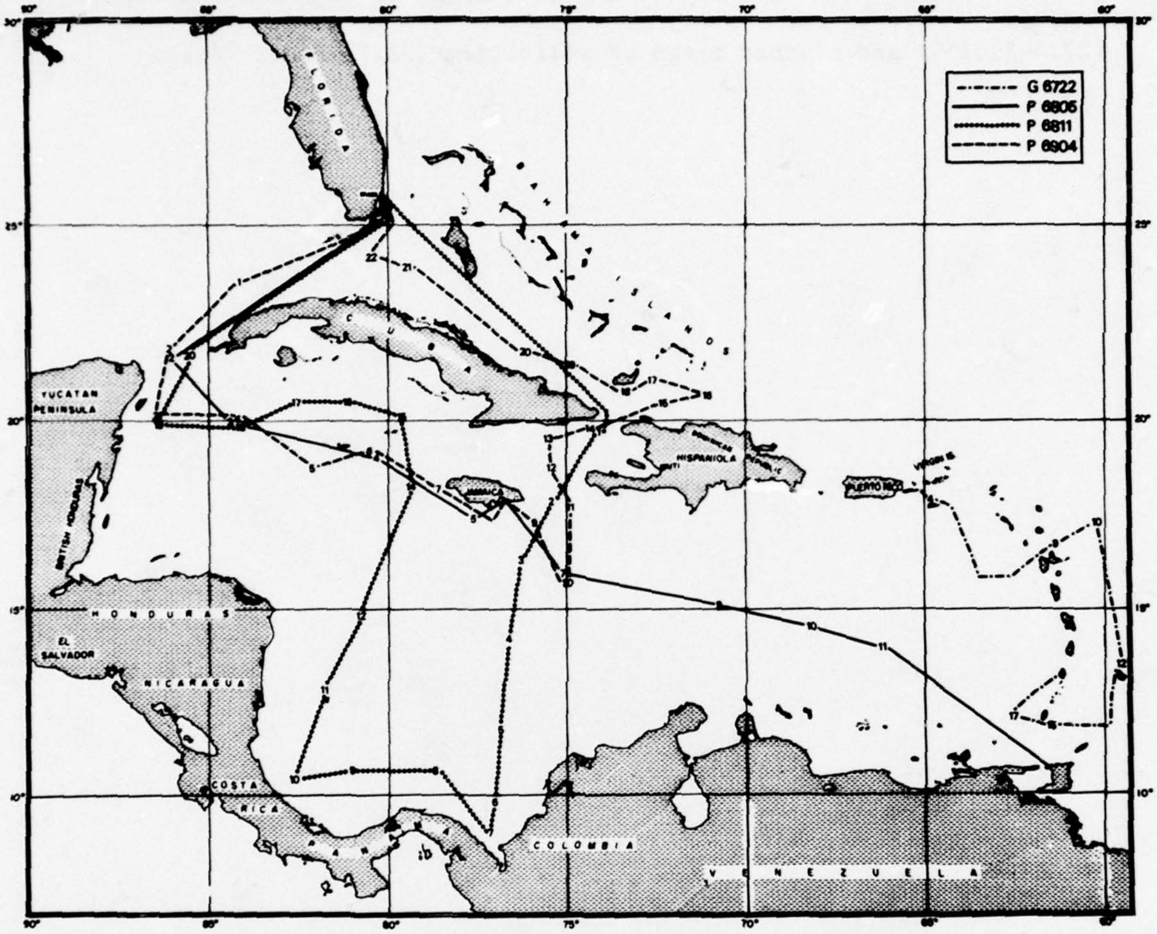

Figure 10. Tracks of cruises G 6722, P 6805, P 6811 and P 6904

Orinoco and other South American rivers (Richards, 1960; Gade, 1961; Ljöen & Herrera, 1965). In the present study, surface waters during the wet season were characterized by a narrow range of high temperatures (27.6-29.2°C) and a broad range of salinities (32.71-36.48 ‰).

TABLE 1

Hydrographic profile of the Brownson Deep at 19°35'N, 67°14'W on 6-7 November 1969. Data from 1-1500 m obtained with STD probe at 1000-1030 hours GMT and from 1925-7431 m, by hydrocast at 2015-2330 hours GMT. Bottom at 7970 m.

Depth (m)	Temperature (°C)	Salinity (°/oo)	Depth (m)	Temperature (°C)	Salinity (°/oo)	Oxygen (ml/l)
1	28.73	34.44	1020	5.69	34.97	
12	28.73	34.44	1050	5.56	34.97	
24	28.95	35.97	1080	5.43	35.00	
36	28.85	35.80	1110	5.34	35.00	
48	28.82	35.96	1140	5.20	35.01	
60	27.54	36.04	1170	5.05	35.02	
72	26.50	36.35	1200	4.94	35.02	
84	-	36.59	1230	4.86	35.02	
96	-	36.75	1260	4.79	35.02	
108	-	36.85	1290	4.68	35.02	
120	23.29	36.76	1320	4.57	35.02	
132	22.90	36.90	1350	4.50	35.02	
144	22.54	36.90	1380	4.37	35.00	
156	22.16	36.87	1410	4.29	35.00	
168	21.57	36.84	1440	4.21	35.00	
180	21.09	36.81	1470	4.17	35.00	
192	20.48	36.76	1500	4.11	35.01	
204	19.75	36.69	1925	3.66	35.00	6.09
216	19.25	36.66	2927	3.00	34.98	6.09
240	18.72	36.60	3928	2.42	34.94	6.16
264	18.37	36.56	4930	2.33	34.92	6.13
288	18.03	36.53	5930	2.01	34.90	5.74
312	17.82	36.50	6931	2.13	34.86	5.65
336	17.55	36.46	7431	2.23	-	5.67
360	17.19	36.39				
384	16.80	36.32				
408	16.09	36.14				
432	15.43	36.07				
456	14.60	35.94				
480	14.03	35.72				
504	13.71	35.78				
528	13.00	35.69				
552	12.47	35.61				
576	11.84	35.49				
600	11.32	35.47				
630	10.54	35.32				
660	9.83	35.21				
690	9.05	35.10				
720	8.58	35.06				
750	8.25	35.09				
780	8.04	35.03				
810	7.68	35.00				
840	7.25	34.95				
870	6.92	34.98				
900	6.81	34.96				
930	6.39	34.93				
960	6.29	34.95				
990	6.03	34.98				

TABLE 2

Hydrographic profile of the Bartlett Deep at 19°02'N, 80°33'W on 25 June 1966: 4069-6907 m at 1210-1502 hours GMT and 1-2970 m at 1544-1735 hours GMT. Bottom at 6950 m.

Depth (m)	Temperature (°C)	Salinity (°/oo)	Oxygen (ml/l)	PO_4-P (µg-at/l)
1	28.33	36.07	4.49	0.01
10	28.31	36.08	4.46	0.01
20	28.26	36.07	4.56	0.07
29	27.96	36.09	4.58	0.03
49	27.66	36.12	4.64	0.10
74	26.90	36.21	4.64	0.14
99	26.05	36.18	4.66	0.10
148	24.61	36.57	4.14	0.19
198	22.50	36.78	3.86	0.26
248	20.63	36.72	3.85	0.27
297	18.87	36.57	4.00	0.40
396	17.22	36.35	4.20	0.50
496	14.29	35.85	3.50	1.04
695	9.33	35.09	2.89	1.82
993	5.35	34.89	3.89	1.93
1191	4.65	34.96	4.68	1.71
1486	4.34	34.98	5.23	1.45
1980	4.21	34.99	5.70	1.29
2475	4.11	34.99	5.81	1.31
2970	4.13	34.98	5.75	1.31
4069	4.28	35.00	5.73	1.30
5067	4.39	35.00	5.79	1.30
6064	4.52	34.99	5.78	1.30
6907	4.66	34.99	5.80	1.30

TABLE 3

Hydrographic profile of the Bartlett Deep at Station 6, P 6904, at 19°06'N, 80°23'W on 17 April 1969 at 0458-0553 hours GMT. Bottom at 5319 m.

Depth (m)	Temperature (°C)	Salinity (°/₀₀)	Water Mass
1	27.82	35.80	Tropical Surface Water
12	27.71	35.77	
24	27.47	35.76	
36	27.34	35.75	
48	27.16	35.75	
60	26.80	35.75	
72	26.62	35.82	
84	26.46	35.96	
96	26.41	36.13	
108	26.10	36.13	
120	25.87	36.25	Subtropical Underwater
132	25.61	36.37	
144	25.14	36.55	
156	24.20	36.72	
168	23.51	36.77	
180	22.80	36.77	
192	22.16	36.79	Core of SUW
204	21.65	36.78	
216	21.01	36.78	
240	19.82	36.67	
264	18.50	36.52	
288	17.80	36.43	
312	17.34	36.38	
336	16.95	36.30	
360	16.22	36.18	
384	15.44	36.02	
408	14.84	35.94	
432	14.09	35.79	Core of North Atlantic
456	13.20	35.66	Central Water
480	12.56	35.54	
504	12.14	35.48	
528	11.82	35.44	
552	11.09	35.31	
576	10.61	35.26	
600	10.12	35.21	
630	9.46	35.09	
660	9.21	35.06	
690	8.73	34.99	
720	8.07	34.93	
750	7.68	34.88	Subantarctic Intermediate Water
780	7.38	34.87	
810	7.09	34.84	
840	6.72	34.83	Core of SAIW
870	6.54	34.83	
900	6.30	34.84	

TABLE 3. Continued

Depth (m)	Temperature (°C)	Salinity (°/₀₀)	Water Mass
930	5.99	34.87	
960	5.75	34.89	
990	5.52	34.91	
1020	5.28	34.92	
1050	5.08	34.94	
1080	4.97	34.95	North Atlantic Deep Water
1110	4.82	34.96	
1140	4.74	34.96	
1170	4.65	34.97	
1200	4.59	34.97	
1230	4.54	34.98	
1260	4.50	34.98	
1290	4.45	34.99	
1320	4.43	34.99	
1350	4.40	34.99	
1380	4.38	34.99	
1410	4.36	34.99	
1440	4.35	35.00	
1470	4.33	35.00	
1500	4.32	35.01	

TABLE 4

Hydrographic profile at Station 18, P 6803, at 17°20'N, 85°25'W in the western Yucatan Basin, on 22 April 1968 at 1306 hours GMT. Bottom depth 4863 m.

Depth (m)	Temperature (°C)	Salinity (°/oo)	Oxygen (ml/1)	PO_4-P (μg-at/1)
0	26.66	36.14	4.57	0.09
19	26.67	36.14	4.55	0.09
39	26.65	36.16	4.57	0.11
59	25.40	36.13	4.56	0.10
68	25.81	36.14	4.59	0.09
78	26.18	36.17	4.49	0.09
88	25.96	36.23	4.44	0.11
98	25.59	36.34	4.50	0.14
118	24.16	36.61	3.94	0.23
147	20.76	36.73	3.34	0.50
196	-	36.46	3.58	0.66
490	9.02	35.12	2.83	1.93
983	4.88	34.93	4.27	1.85
1474	4.28	34.98	4.93	1.59
2465	4.13	35.01	5.58	1.52
3447	4.22	35.00	5.61	1.58
4427	4.34	35.03	5.95	1.51

TABLE 5

Hydrographic profile at Station 18, P 6811, at 19°54'N, 84°14'W in the central Yucatan Basin, on 17 November 1968 at 0805-0906 hours GMT. Bottom at 4410 m.

Depth (m)	Temperature (°C)	Salinity (°/..)	Water Mass
2	27.73	36.06	Tropical Surface Water
12	27.74	36.06	
24	27.74	36.06	
36	27.75	36.06	
48	27.75	36.06	
60	27.76	36.06	
72	27.75	36.07	
84	27.75	36.07	
96	27.75	36.06	
108	27.76	36.07	
120	27.74	36.07	
132	27.17	36.27	
144	26.70	36.31	
156	26.18	36.33	
168	25.51	36.41	Subtropical Underwater
180	24.52	36.55	
192	23.72	36.70	
204	23.10	36.71	Core of SUW
216	22.18	36.66	
240	20.68	36.59	
264	19.61	36.53	
288	18.77	36.52	
312	18.12	36.37	
336	17.67	36.39	
360	17.24	36.31	
384	16.67	36.23	
408	16.13	36.05	
432	15.67	36.06	
456	14.83	35.84	
480	14.25	35.76	Core of North Atlantic
504	13.54	35.61	Central Water
528	12.59	35.52	
552	11.93	35.42	
576	11.06	35.28	
600	10.26	35.18	
630	9.44	35.06	
660	8.91	34.99	
690	8.28	34.92	
720	7.78	34.87	Subantarctic Intermediate Water
750	7.30	34.84	
780	6.93	34.81	
810	6.45	34.79	Core of SAIW
840	6.14	34.81	
870	5.91	34.83	
900	5.60	34.84	

TABLE 5 (continued)

Depth (m)	Temperature (°C)	Salinity (°/₀₀)	Water Mass
930	5.36	34.85	
960	5.12	34.88	
990	4.97	34.90	North Atlantic Deep Water
1020	4.88	34.89	
1050	4.76	34.91	
1080	4.68	34.92	
1110	4.64	34.92	
1140	4.57	34.93	
1170	4.53	34.93	
1200	4.47	34.94	
1230	4.43	34.94	
1260	4.40	34.94	
1290	4.38	34.94	
1320	4.35	34.95	
1350	4.32	34.95	
1380	4.31	34.95	
1410	4.28	34.95	
1440	4.27	34.96	
1470	4.25	34.96	
1500	4.24	34.96	

TABLE 6

Hydrographic profile at Station 4, P 6811, at 14°10'N, 76°34'W in the central Colombian Basin, on 6 November 1968 at 1119-1220 hours GMT. Bottom at 4082 m.

Depth (m)	Temperature (°C)	Salinity (°/₀₀)	Water Mass
3	28.14	35.48	Tropical Surface Water
12	28.15	35.48	
24	28.17	35.48	
36	28.08	35.72	
48	27.55	36.14	
60	26.99	36.26	
72	25.96	36.43	Subtropical Underwater
84	25.08	36.44	
96	24.48	36.67	
108	23.74	36.64	
120	22.70	36.59	
132	22.08	36.70	
144	21.73	36.73	Core of SUW
156	20.67	36.64	
168	20.29	36.70	
180	19.31	36.42	
192	18.71	36.41	
204	18.48	36.46	
216	18.07	36.46	
240	17.39	36.29	
264	16.39	36.14	
288	15.55	35.98	
312	14.97	35.88	
336	14.30	35.80	
360	13.68	35.66	Core of North Atlantic
384	13.05	35.61	Central Water
408	12.26	35.48	
432	11.48	35.30	
456	10.81	35.23	
480	10.26	35.20	
504	9.78	35.10	
528	9.27	35.00	
552	8.86	34.98	
576	8.33	34.85	
600	8.01	34.86	Subantarctic Intermediate Water
630	7.70	34.81	
660	7.38	34.81	
690	7.06	34.75	
720	6.66	34.71	Core of SAIW
750	6.56	34.74	
780	6.44	34.75	
810	6.28	34.77	
840	6.08	34.79	
870	5.96	34.79	
900	5.85	34.80	

TABLE 6 (continued)

Depth (m)	Temperature (°C)	Salinity (°/₀₀)	Water Mass
930	5.78	34.82	
960	5.59	34.83	
990	5.46	34.84	
1020	5.34	34.86	
1050	5.22	34.87	
1080	5.10	34.88	
1110	4.99	34.90	North Atlantic Deep Water
1140	4.90	34.91	
1170	4.84	34.92	
1200	4.80	34.92	
1230	--	---	
1260	4.65	34.93	
1290	4.61	34.94	
1320	4.55	34.94	
1350	4.51	34.94	
1380	4.47	34.95	
1410	4.43	34.95	
1440	4.41	34.95	
1470	4.38	34.96	
1494	4.36	34.96	

TABLE 7

Hydrographic profile at Station 9, P 6811, at 10°25'N, 80°55'W in the southwestern Colombian Basin, on 10 November 1968 at 0644-0737 hours GMT. Bottom at 3332 m.

Depth (m)	Temperature (°C)	Salinity (°/₀₀)	Water Mass
2	27.69	34.85	Tropical Surface Water
12	27.94	35.33	
24	25.08	36.52	Subtropical Underwater
36	23.34	36.66	Core of SUW
48	21.90	36.63	
60	20.69	36.64	
72	19.69	36.58	
84	18.81	36.45	
96	18.08	36.39	
108	17.62	36.33	
120	17.25	36.28	
132	16.73	36.18	
144	16.24	36.12	
156	15.74	36.04	
168	15.36	35.96	
180	15.10	35.93	
192	14.57	35.81	
204	14.26	35.78	Core of North Atlantic Central Water
216	13.87	35.69	
240	13.20	35.55	
264	12.67	35.49	
288	11.83	35.38	
312	11.11	35.26	
336	10.53	35.16	
360	9.79	35.07	Subantarctic Intermediate Water
384	9.25	35.00	
408	9.03	35.00	
432	8.69	34.95	
456	8.18	34.88	
480	7.94	34.87	
504	7.78	34.84	
528	7.66	34.84	
552	7.52	34.84	
576	7.26	34.82	
600	7.01	34.80	
630	6.77	34.78	
660	6.66	34.78	
690	6.37	34.77	Core of SAIW
720	6.20	34.78	
750	5.95	34.80	
780	5.78	34.81	
810	5.72	34.82	
840	5.65	34.83	
870	5.46	34.85	

TABLE 7 (continued)

Depth (m)	Temperature (°C)	Salinity (°/₀₀)	Water Mass
900	5.31	34.89	
960	5.07	34.88	North Atlantic Deep Water
990	4.96	34.89	
1020	4.93	34.90	
1050	4.89	34.90	
1080	4.86	34.91	
1110	4.79	34.91	
1140	4.76	34.91	
1170	4.73	34.92	
1200	4.68	34.92	
1230	4.64	34.92	
1260	4.57	34.93	
1290	4.51	34.93	
1320	4.46	34.94	
1350	4.42	34.94	
1380	4.36	34.95	
1410	4.31	34.95	
1440	4.26	34.95	
1470	4.24	34.96	
1500	4.22	34.96	

TABLE 8

Hydrographic profile at Station 14, P 6602, at 15°00'N, 64°01'W in the Venezuela Basin, on 14 February 1966 at 0153-0311 hours GMT. Bottom at 3074 m.

Depth (m)	Temperature (°C)	Salinity (°/oo)	Oxygen (ml/l)	PO_4-P (µg-at/l)
1	23.37	35.94	4.73	0.03
10	26.38	35.95	4.71	0.02
19	26.35	35.94	4.70	0.03
29	26.38	35.97	4.72	0.03
50	26.43	35.94	4.76	0.03
75	25.86	36.31	4.39	0.10
99	23.36	36.78	4.00	0.19
149	19.61	36.60	3.52	0.47
199	17.33	36.32	3.45	0.67
249	15.85	36.10	3.40	0.80
299	14.46	35.87	3.33	0.96
399	11.17	35.32	3.10	1.46
499	8.54	34.93	2.97	1.87
698	6.55	34.73	3.08	2.13
997	5.01	34.91	4.12	1.80
1197	4.42	34.97	4.67	1.66
1497	4.16	34.98	4.87	1.57
1696	4.11	34.98	5.06	1.54
1992	4.08	34.99	5.08	1.54
2489	4.08	34.99	5.20	1.53
3017	4.15	34.99	5.16	1.51

TABLE 9

Hydrographic profile at Station 9, P 6911, at 16°42'N, 67°57'W in the north central Venezuelan Basin, on 31 October 1969 at 0747-0820 hours GMT. Bottom at 4671 m.

Depth (m)	Temperature (°C)	Salinity (°/°°)	Water Mass
1	29.17	34.48	Tropical Surface Water
12	29.17	34.48	
24	29.18	34.48	
36	29.41	35.14	
48	29.21	35.30	
60	28.76	35.58	
72	28.34	35.67	
84	27.52	35.86	
96	27.04	36.11	
108	26.51	36.31	
120	26.02	36.46	
132	25.60	36.65	Subtropical Underwater
144	24.95	36.74	
156	24.34	36.66	
168	22.96	36.68	
180	22.07	36.70	
192	21.39	36.75	Core of SUW
204	20.46	36.66	
216	19.79	36.58	
240	18.44	36.42	
264	17.50	36.30	
288	16.33	36.13	
312	15.75	36.00	
336	14.96	35.88	
360	14.36	35.80	Core of North Atlantic
384	13.65	35.65	Central Water
408	13.03	35.60	
432	12.75	35.56	
456	11.97	35.43	
480	11.34	35.35	
504	10.91	35.28	
528	10.34	35.19	
552	9.92	35.15	
576	9.38	35.05	
600	9.04	34.98	
630	8.45	34.90	
660	8.00	34.89	Subantarctic Intermediate Water
690	7.71	34.87	
720	7.34	34.80	
750	6.94	34.79	
780	6.63	34.78	
810	6.53	34.79	
840	6.19	34.77	Core of SAIW
870	5.96	34.78	

TABLE 9 (continued)

Depth (m)	Temperature (°C)	Salinity (°/₀₀)	Water Mass
900	5.85	34.79	
930	5.76	34.82	
960	5.62	34.85	
990	5.40	34.88	
1020	5.22	34.90	
1050	5.03	34.91	
1080	4.92	34.92	North Atlantic Deep Water
1110	4.80	34.93	
1140	4.70	34.94	
1170	4.61	34.94	
1200	4.52	34.94	
1230	4.46	34.95	
1260	4.40	34.95	
1290	4.36	34.95	
1320	4.33	34.95	
1350	4.30	34.96	
1380	4.28	34.96	
1410	4.25	34.96	
1440	4.23	34.96	
1470	4.21	34.96	
1500	4.20	34.97	

TABLE 10

Hydrographic profile of Station 11, P 6803, in the Gulf of Mexico at 25°59'N, 86°11'W, obtained by hydrocast on 16 April 1968. Time 1229 hours GMT. Bottom depth 3152 m.

Depth (m)	Temperature (°C)	Salinity (°/oo)	Oxygen (ml/l)	PO_4-P (µg-at/l)
0	23.35	36.40	4.71	0.16
19	22.50	36.42	5.04	0.16
39	20.75	36.41	4.98	0.16
58	20.16	36.39	4.94	0.16
68	19.10	36.33	3.56	0.60
78	18.43	36.28	3.34	0.70
87	17.92	36.22	3.98	0.57
97	17.59	36.22	3.35	0.79
117	16.57	36.05	3.14	0.83
146	15.48	35.93	3.37	1.02
195	13.73	35.59	3.07	1.28
487	7.53	34.80	2.92	2.21
977	4.66	34.81	4.37	1.89
1467	4.23	34.85	4.94	1.75
1958	4.23	34.84	4.97	1.69
2449	4.27	34.84	5.01	1.67

TABLE 11

Partial hydrographic profiles obtained from hydrocasts at four stations north of Venezuela, P 6701: Sta. 19, 13°30'N, 68°46'W, 4 February 1967, 1735-1806 hours GMT, bottom at 4263 m; Sta. 20, 13°15'N, 70°41'W, 5 February 1967, 1451-1522 hours GMT, bottom at 2103 m; Sta. 21, 13°00'N, 72°41'W, 6 February 1967, 0412-0431 hours GMT, bottom at 4144 m; and Sta. 22, 12°40'N, 74°40'W, 6 February 1967, 1817-1849 hours GMT, bottom at 3908 m. Core of Subtropical Underwater underlined.

Station 19			Station 20			Station 21			Station 22		
Depth (m)	Temp. (°C)	Sal. (°/₀₀)	Depth (m)	Temp. (°C)	Sal. (°/₀₀)	Depth (m)	Temp. (°C)	Sal. (°/₀₀)	Depth (m)	Temp. (°C)	Sal. (°/₀₀)
1	26.37	35.46	0	24.92	36.62	0	25.38	36.94	0	24.85	36.69
21	26.33	35.45	19	24.89	36.62	20	25.13	36.60	20	24.78	36.68
31	26.33	35.45	29	24.89	36.73	30	24.53	36.75	30	24.79	36.69
41	26.34	35.44	39	24.91	36.63	39	23.47	36.83	39	24.80	36.87
61	26.22	35.63	49	24.37	36.66						
69	26.08	35.82	58	23.89	36.80	59	21.90	36.85	59	24.71	36.68
76	26.32	36.32	68	22.91	36.77	69	20.99	36.79	69	24.72	36.69
79	26.23	36.46	78	22.28	36.79	79	20.28	36.75			
89	25.12	36.64	93	21.67	36.76				89	24.00	36.75
98	24.09	36.78	97	21.47	36.77	98	18.69	36.57	99	22.61	36.82
117	22.03	36.83	116	19.81	36.63	118	18.09	36.49	119	20.73	36.72

The lowest surface salinity, 32.71 °/₀₀, which forms an extreme in the T-S-P diagrams (e.g., Figs. 11, 15), was recorded westnorthwest of St. Vincent (Table 20: P 6911, Sta. 6). Additional data showing the extent of fresh water influence in the upper 100 m at that station are given in Table 12. Measurements of the Tropical Surface Water in the wet season are also given in Tables 6 and 9. Conversely, temperatures of surface waters in the dry season were cooler and the range was greater (25.2-28.1°C), while salinities were higher, over a lesser range (35.31-36.40 °/₀₀). Data from the upper 117 m during dry season at Sta. 19, P 6701 are listed in Table 11.

TABLE 12

Hydrographic data from Sta. 6, P 6911, west of St. Vincent, B.W.I.

Depth (m)	Temperature (°C)	Salinity (°/₀₀)	Depth (m)	Temperature (°C)	Salinity (°/₀₀)
1	28.84	32.71	60	27.55	36.10
12	28.84	34.53	72	25.50	36.54
24	28.84	33.06	84	23.44	36.73
36	28.82	34.80	96	21.57	36.53
48	28.50	35.20	108	20.75	36.55

The high-salinity water mass termed Subtropical Underwater (SUW) by Wüst (1964) lies beneath the layer of anomalously fresh water at approximately 100-200 m. Examples of the levels at which SUW can be identified in our data are noted in Tables 3, 5, 6, 7 and 9. Termed Maximum Salinity Water by some authors, its salinities range above 36.25-36.50 °/₀₀ and its temperatures, usually below 26°C. The core, also noted in the tables cited, is "...characterized by an intermediate maximum of salinity in depths between 50 and 200 meters" (Wüst, 1964). Derived from the western North Atlantic, it originates between 21° and 23°N, near 55°W where the surface salinity exceeds 37.2 °/₀₀, according to Wüst. Worthington (1971) put its source

farther north, at 27°N, in the mid-Atlantic. However, Stalcup & Metcalf (1972) disagree. They used data from several extensive cruises to identify water types in the eastern Caribbean and the North Atlantic between approximately 0° and 24°N and 44° and 69°W, and they measured currents in four Lesser Antillean passages. Their data show the major Caribbean inflow moving through the Grenada, St. Vincent and St. Lucia passages and the maximum salinity water, also characterized by low oxygen content, originating in a broad area lying between 5° and 15°N in the North Atlantic, extending east from the islands to at least 32°W. Subtropical Underwater of higher oxygen content (4.5 ml/l at 18°C) found in the north-central Caribbean is formed in winter in the northern Sargasso Sea and probably enters the Caribbean through the Windward Passage, according to Worthington (1959). The characteristics of low oxygen content in maximum-salinity waters of 16-23°C which Stalcup & Metcalf (1972) identified both in the southwestern North Atlantic and in the eastern Caribbean appear in our data, e.g., 3.45 ml/l at 17.33°C in the Venezuela Basin (Table 8). In contrast, the oxygen level was 4.20 ml/l at 17.22°C in the Bartlett Deep (Table 2).

Between the warm and cold water spheres lies a boundary region in which Subtropical Underwater and Subantarctic Intermediate Water (SAIW) are mixed, above and below, with North Atlantic Central Water (NACW). The level of the core of NACW, at approximately 14°C and 35.7 °/₀₀, is indicated in Tables 3, 5, 6, 7 and 9. The best definition of the boundary, according to Wüst (1964), is the core of the intermediate oxygen minimum "...which approximately corresponds to the 8°-10° surface and 34.90-35.00 °/₀₀ surface." In the Cayman, Yucatan and Venezuelan Basins, this core appears in our data at 695 m, 490 m and 499 m, respectively (Tables 2, 4 and 8).

The core of the colder, less saline (5-8°C, 34.69-35.12 °/₀₀) SAIW lies

at the intermediate salinity minimum somewhere between 700 and 850 m (Wüst, 1964). In Tables 2 and 4, the apparent core was far deeper (993 and 983 m) because of inadequate sampling, but it is easily found in Tables 3, 5, 6, 7, 8 and 9, with an overall range of 690-840 m, 6.19-6.72°C and 34.71-34.83 °/₀₀. The layer extends from approximately 700 to 1200 m, below which North Atlantic Deep Water (NADW) and Caribbean Bottom Water (BW) fill the basins.

NADW is characterized by temperatures of less than 5°C and salinities of 34.89-35.03 °/₀₀. Its core is identified with the upper intermediate oxygen maximum at depths of 1800-2500 m. Measurements near the core, all close to 2500 m, show the relatively low oxygen level in the Venezuelan Basin (5.20 ml/l, Table 8) compared with 5.58 ml/l in the Yucatan Basin (Table 4), as illustrated by Wüst (1964), and 5.81 ml/l in the Cayman Basin (Table 2).

The few data on Bottom Water included here do not show the wide differences in salinity in the basins from southeast to northwest graphed by Wüst. Similar measurements below and slightly above 35 °/₀₀ were recorded in the Cayman and Yucatan Basins, but our figures for deep water in the Venezuelan Basin (Table 8) are far lower than Wüst's, of nearly 36.5 °/₀₀. However, the data agree in that oxygen content of BW is high in western basins (5.75-5.80 ml/l, Table 2; 5.61-5.95 ml/l, Table 4) compared with the Venezuelan Basin (5.16 ml/l, Table 8). Also, rising temperatures at the greatest depths sampled is a feature of all profiles derived from hydrographic casts in the Caribbean and the Gulf of Mexico and Brownson Deep as well (Tables 1, 2, 4, 8 and 10).

The residence time of the deep water in the Caribbean basins has been disputed for over 20 years. According to Dietrich (1939), Wüst (1964) and

others, it is more or less continuously renewed, principally by the flow of North Atlantic deep water over the sill of the Windward Passage into the Cayman and Yucatan Basins and over the Anegada/Jungfern sill into the Venezuelan and Colombian Basins. Worthington (1955) was the first to suggest that the deep water had not been renewed in recent times. His premise, based on relatively low oxygen values in the basins, was countered by Wüst (1964), who showed that the observed differences could be accounted for by changes in sampling techniques and procedures of standardization on the various cruises cited. In studies of the Venezuelan Basin, however, Richard (1958) had found much higher levels of dissolved silicate, in addition to low oxygen and high phosphate, in the deep water than in the Atlantic outside the sills. Sturges (1965), investigating the characteristics of salinity and potential temperature in the major basins, remarked on the homogeneity of waters below 2000 m in each basin but noted that they are different in the eastern (Venezuelan and Colombian) and western (Cayman and Yucatan) areas. Sturges found indications of sporadic inflow through the Windward Passage into the western basins and occasional overflow across the Jamaican Ridge into the Colombian Basin, but no evidence of inflow over the Jungfern sill. If the deep waters in the eastern basins have not been renewed in recent years, then the dissolved oxygen should be lower there than in the western basins, as Worthington originally proposed. Sturges cited differences of 0.5-0.7 ml/1 dissolved oxygen below 2500 m in the two areas. Our data from depths closest to 2500 m in the Bartlett Deep of the Cayman Basin (5.81 ml/1, Table 2) compared with the Venezuela Basin (5.20 ml/1, Table 8) show a difference of 0.61 ml/1. In contrast, the dissolved oxygen at this level in the Brownson Deep, North Atlantic, was 6.09 ml/1 (Table 1). Further evidence for long residence of deep water was provided by Szabo

et al. (1967), who measured the vertical and areal distribution of radiocarbon, radium-226, and oxygen in the Colombian and Venezuelan Basins and estimated the renewal time as 50-400 years.

Hydrographic observations made in 1968 in the Jungfern Passage and the Venezuela Basin have been used by Ross & Mann (1971) to construct a potential temperature section across the sill for depths greater than 1300 m. They found the cold bottom water on the sill denser than that at stations within the basin. They concluded that "...cold dense water...available on top of the sill...apparently is not cascading down into the Venezuela Basin." Worthington (1966) had already stated there is no evidence that bottom water is entering the Caribbean at present through either the Jungfern or Windward Passages, after studying sections through both. To explain the apparent lack of movement into the Venezuela Basin, he postulated the existence of a deep westward current flowing along the ridge between St. Croix and Puerto Rico, where the Jungfern sill is located. Ross & Mann agreed that the dynamics of the deep water near the sill must function to retain the denser water as there is no topographic barrier to its movement. The preponderance of data indicates that the North Atlantic Deep Water in the Caribbean is renewed very slowly, even in the western basins.

Upwelling in the southern Caribbean has been described by several authors, among them Richards (1960) and Gordon (1967), who diagrammed areas of upwelling and of possible upwelling in the dry season off Venezuela and Colombia. This phenomenon appears in data collected in January at three stations, 20 - 22, of P 6701 (Fig. 9, Table 11). Station 19, to the east and just outside the area diagrammed by Gordon, was included in Table 11 to show that the TSW, though typical in temperature and salinity, formed a relatively thin layer and consequently the SUW and its core were found

at unusually shallow depths. At Stations 20 and 21, about 60 miles off the coast, TSW was absent altogether, SUW was upwelled to the surface, and its core was extremely shallow at 58 and 59 m. The TSW was also missing at Station 22, about 100 miles north of the Colombian coast, but the core of the SUW had shifted down to 99 m.

Upwelling was also found in the Central American cyclonic gyre off the coasts of Panama, Costa Rica and Nicaragua. The track of P 6811 passed through this area (Fig. 10), and the hydrographic data from several stations demonstrate it. The TSW was not displaced as it was off South America. Instead, the upper 1000 m, approximately, were affected by an uplifting. Whereas the causes of upwelling in the former situation are attributed to the forces of winds and currents, orographic lifting within the cyclonic circulation may account for the phenomenon in this area. To the north, the Jamaican Ridge forms a broad barrier at 2000 m and upward, extending across the Caribbean from Nicaragua and Honduras to Hispaniola (Fig. 2). The data collected on P 6811 showed that the core of the SUW sloped strongly upward from Stations 6 to 9 (144 m, 132 m, 96 m, 36 m) and then downward at Stations 10, 11 and 12 (84 m, 108 m, 108 m), again reaching 144 m at Station 14, in the north central Caribbean west of Jamaica. Conditions of upwelling were most pronounced at Station 9 (Table 7) where a few meters of TSW floated atop SUW, recognizable at 24 m, and the core of the SUW lay around 36 m. The layers of SAIW and NADW were likewise shifted upward. Examination of the vertical distribution of chaetognaths first brought these conditions to our attention. Three species, Sagitta lyra, S. macrocephala and Eukrohnia bathyantarctica were numerous at unusually shallow depths at Station 9. Also, Haagensen (1974), who used the Caribbean samples to study the distribution of thecosomes ("pteropods"), found them most abundant at

Stations 4 and 7 in the gyre, which, as he pointed out, is fed by waters from regions of upwelling along coastal Venezuela, Colombia, Panama and Costa Rica.

Concerning circulation in the Caribbean, Wüst (1964) and Gordon (1967) have pointed out that, in the absence of widespread densimetric gradients, wind provides the major source of energy for motion, and that the Northeast Trades drive the surface currents of the Equatorial Current System. A branch of this system, the Guiana Current, flows swiftly northwestward along South America, entering the Caribbean through passages between islands of the Lesser Antilles to become the Caribbean Current, which is the principal source of transport. The Tropical Surface Water, the Subtropical Underwater and the Subantarctic Intermediate Water all flow westward, then northwestward toward the Yucatan Channel, through which they pass into the Gulf of Mexico and the Florida Straits where they contribute to the formation of the Gulf Stream System. The axis of the Caribbean Current enters between Grenada and Trinidad. It nearly parallels the Venezuelan and Colombian coasts and then gradually turns northwest at about 77°W, crossing the Jamaica Ridge between 13° and 16°N and flowing over the Cayman and Yucatan Basins to exit on the western side of the Yucatan Channel. Gordon (1967), who applied the geostrophic method to hydrographic profiles across the Caribbean and the Yucatan Channel and showed velocities in the three layers, found that the volume transport across the meridional section in the Caribbean is approximately 31×10^6 m^3/ sec toward the west.

Surface currents in the Caribbean and adjacent areas have recently been reexamined in a study combining geostrophic calculations and thermocline topography with data from drift bottles (Brucks, 1971). Concerning general surface circulation, the results agreed with the known pattern of

westward drift throughout the Caribbean. A variation in the surface circulation in the Panamanian region, involving cyclonic circulation off Costa Rica but offshore along western Panama, suggested the need for further study of the area. Brucks' report that a "predominantly north current - in lieu of a westward drift - was evident along the island chain north of St. Vincent Island", was based on recovery of bottles released in February as well as others which suggested that the current also flowed north in summer and early fall. Brucks pointed out that this is contrary to historical data, including Wüst's (1964) representations. As a persistent feature of circulation in the area, a northward current immediately east of the Windward Islands is difficult to reconcile with the direct-current and other measurements and the analysis made by Stalcup & Metcalf (1972), referred to earlier. On the basis of further data from drift bottles, which showed a surface circulation similar to that illustrated by Wüst, Metcalf & Stalcup (1974) inferred "...that the major part of the surface water crossing the Caribbean Sea from east to west enters that sea through the southeastern and not the northeastern passages."

Little is known about currents below 1200 m except that they are oriented westward and are slow, <5 cm/sec, except perhaps in the depths of western basins where velocities exceeding 10 cm/sec have been measured (Gordon, 1967).

TABLE 13

STATION DATA, CRUISE P-6606

STA. NO.	DATE 1966	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)	O_2 (ml/l)	PO_4-P (μg-at/l)
4	26 June	2125-2225	17°06'N, 76°48'W	1697	surf	27.9	36.07	4.50	0.00
					103	26.4	36.28	4.49	0.03
					285	18.2	36.45	3.61	0.46
					593	9.9	35.20	2.98	1.66
					700	7.2	34.87	2.97	2.01
					1000	5.3	34.91	3.99	1.83
8	29 June	2238-2338	13°10'N, 75°00'W	3839	surf	27.6	36.18	4.50	0.01
					100	24.2	36.67	3.81	0.21
					500	9.5	35.09	2.88	1.81
					1000	5.1	34.90	4.01	1.95
					2000	4.1	34.99	4.96	1.59
					3250	4.1	34.99	4.97	1.59
11	1 July	1550-1640	10°32'N, 77°12'W	3239	surf	28.7	36.03	4.49	0.01
		1556-1656			100	20.8	36.74		0.22
					500	8.2	34.94	2.79	1.31
					1000	5.0	34.92	4.08	1.20

CRUISE P-6606
Continued

STA. NO.	DATE 1966	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP (°C)	SALINITY (‰)	O_2 (ml/l)	PO_4-P (µg-at/l)
					2000	4.1	34.98	4.97	1.00
					2500	4.1	34.99	4.98	1.00
12	2 July	0545-0645	10°05'N, 78°22'W	1901	surf	28.9	35.44	4.44	0.00
		0553-0653			100	23.0	36.76	3.75	0.28
					300	12.1	35.47	2.89	1.45
					500	8.2	35.94	2.80	2.29
					1000	5.1	34.90	4.00	1.99
					1500	4.2	34.97	4.93	1.68
13	2 July	1400-1500	09°50'N, 78°50'W	1753	surf	29.2	35.21	4.43	0.11
		1546-1646			100	22.7	36.77	3.55	0.31
					300	13.2	35.65	2.99	1.28
					500	8.7	34.99	2.77	1.97
					1000	5.0	34.92	4.20	1.96
					1300	4.5	34.98	4.60	1.84
14	2 July	2237-2337	09°44'N, 79°33'W	219	10	29.0	35.42	4.45	0.03
					100	21.3	36.73	3.45	0.32

TABLE 14

STATION DATA CRUISE P-6701

STA. NO.	DATE 1967	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
1	8 Jan.	2053-2133	23°30'N, 84°12'W	2672	surf	25.2	36.23
		2035-2135			530		
					845		
					1250		
					1725		
					2425		
2	9 Jan.	1425-1525	21°30'N, 85°50'W	1835	surf	25.8	35.93
		1422-1522			90	25.0	36.46
					220*	18.6	36.50
		1740-1840			350		
		1422-1522			500		
		1740-1840			575		
3	10 Jan.	1010-1110	20°00'N, 86°22'W	1799	surf	26.0	35.97
		1047-1139			115	23.8	36.70
					250**	19.9	36.69
					350		
					435		
					750		
					970		
4	11 Jan.	0235-0335	20°00'N, 84°17'W	4398	surf	25.7	36.26
		0359-0459			130	25.1	36.40

* Hydrographic depth 195 m.
** Hydrographic depth 193 m.

C R U I S E P-6701
Continued

STA. NO.	DATE 1967	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
					505		
					1000		
					1338		
					2500		
					3500		
5	12 Jan.	0457-0557	19°35'N, 82°15'W	3997	surf	26.4	35.88
		0510-0610			90	26.1	35.50
					250*	19.8	36.65
					504		
					860		
					1000		
					1830		
8	14 Jan.	1113-1213	19°05'N, 75°40'W	3107	surf	26.4	35.67
		1125-1225			70	26.0	36.30
					250**	20.1	36.78
					505		
					817		
					955		
					1625		
10	28 Jan.	0240-0340	16°00'N, 75°00'W	2968	surf	26.4	35.64
		0249-0345			110	25.7	36.48

* Hydrographic depth 197 m.
**Hydrographic depth 198 m.

CRUISE P-6701
Continued

STA. NO.	DATE 1967	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
					500	11.2	35.32
					1000	5.5	34.88
					1800	4.2	35.00
					2200	4.1	34.97
					2850		
11	28 Jan.	2025-2130	15°45'N, 73°00'W	3025	surf	26.3	35.23
		2037-2137			110	25.3	36.66
					500	10.1	35.19
					975	5.4	34.94
					1525	4.2	35.00
					1800	4.2	34.98
					2375	4.1	34.95
12	29 Jan.	1652-1748	15°45'N, 71°00'W	4008	surf	26.3	35.49
		1700-1800			100	25.7	36.69
					500	9.6	35.13
					920	5.9	34.89
					1450	4.2	35.00
					1825	4.1	35.00
					2450	4.1	34.98
		2211-2311			3100	4.2	34.98
					3200	4.2	34.98

CRUISE P-6701
Continued

STA. NO.	DATE 1967	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
13	30 Jan.	1430-1535	15°40'N, 69°00'W	4038	surf	26.4	35.47
		1435-1535			100	24.6	36.73
					450	11.2	35.35
					1000	5.2	34.91
					1500	4.2	34.98
					1950	4.1	34.99
		2057-2157			3100	4.2	35.02
					3200	4.2	35.02
14	31 Jan.	2110-2210	15°35'N, 67°00'W	4865	surf	26.2	35.34
		1240-1340			100	24.0	36.87
					500	10.6	35.26
					1000	5.3	34.93
					1650	4.2	34.98
					2150	4.1	34.99
					2375	4.1	35.00
		2110-2210			3850	4.3	34.99
					4350	4.3	34.99
16	2 Feb.	1505-1605	15°20'N, 63°00'W	2347	surf	26.2	35.85
		1501-1601			100	25.2	36.46
					398	11.3	35.29
					775	6.1	34.74
					1250	4.4	34.99

C R U I S E P-6701
Continued

STA. NO.	DATE 1967	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
18	4 Feb.	0959-1059	13°50'N, 66°45'W	5060	surf	26.3	35.41
					100	24.3	36.97
					500	9.0	35.04
					1000	5.1	34.90
		0423-0523			1625	4.2	34.96
		0959-1059			2200	4.1	34.98
					2650	4.1	34.97
		0423-0523			3800	4.2	35.00
					4350	4.3	34.98
20	5 Feb.	1640-1715	13°15'N, 70°40'W	2103	surf	24.9	36.62
		1635-1735			100	21.2	36.75
					250	15.3	36.03
					450	12.4	35.73
					850	6.7	35.12
					1050	4.9	34.96
					1500	4.3	34.99
22	6 Feb.	2000-2100	12°40'N, 74°40'W	3908	surf	24.9	36.69
					100	22.5	36.82
					475	8.5	34.93
					1000	5.0	34.90
					1650	4.2	34.97

CRUISE P-6701
Continued

STA. NO.	DATE 1967	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
					2000	4.1	34.96
	7 Feb.	0153-0253			2350	4.1	35.02
24	8 Feb.	1506-1606	11°15'N, 78°20'W	3530	surf	26.2	35.89
		1502-1602			100	20.9	36.78
					500	8.5	34.98
					1000	5.0	34.93
					1800	4.2	35.01
					2600	4.1	35.04
					3000	4.1	35.01

TABLE 15

STATION DATA, CRUISE G-6722

STA. NO.	DATE 1967	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)	O_2 (ml/l)	PO_4-P (μg-at/l)
4	1 Dec.	0342-0439	17°52'N, 64°49'W	4026	surf	27.8	34.10	4.72	0.21
					55	28.3	35.30	4.81	0.22
					335	16.0	36.19	3.51	1.03
					581	10.3	35.40	3.39	1.67
					1040	5.3	34.98	4.38	1.99
					1520	4.2	35.02	5.08	1.83
9	5,6 Dec.	2310-0010	16°44'N, 61°21'W	1341	surf	27.3	35.40	4.58	0.45
					40	27.5	35.77	5.26	0.20
					155	21.8	37.05	4.21	0.32
					320	15.4	36.17	3.85	0.92
					562	10.1	35.32	3.16	1.80
					875	6.8	35.65	3.89	2.12
					1200				
10	6 Dec.	1606-1706	17°14'N, 60°12'W	5318	surf	27.1	34.83	4.70	0.09
					45	27.1	34.83	4.70	0.12

CRUISE G-6722
Continued

STA. NO.	DATE 1967	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)	O_2 (ml/l)	PO_4-P (µg-at/l)
					225	17.9	36.50	3.78	0.78
					405	13.6	35.82	3.59	1.31
					630	9.3	35.21	3.55	1.77
					824	7.6	35.13	3.87	1.82
					1800	3.9	35.00	6.06	1.35
		1944-2044			3000	2.7	34.96	6.27	1.37
					3500	2.5	34.94	6.30	1.40
					4500				
12	8 Dec.	0143-0245	13°25'N, 59°33'W	1290	surf	27.6	35.84	4.66	0.24
					80	26.5	36.57	5.09	0.22
					181	18.7	36.60	3.82	0.66
					310	14.5	35.95	3.50	1.23
					675	7.8	34.99	3.25	2.15
					1150				
15	11 Dec.	0155-0225	11°48'N, 61°31'W	960	surf	27.1	35.80	4.75	0.23

CRUISE G-6722
Continued

STA. NO.	DATE 1967	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)	O_2 (ml/l)	PO_4-P (µg-at/l)
		0125-0225			30	26.6	35.98	4.61	0.29
					132	18.8	36.51	3.08	0.87
					240	14.0	35.78	3.56	1.35
					450	8.2	34.85	3.25	2.23
					635				
17	11 Dec.	1647-1747	12°06'N, 62°35'W	2772	surf	27.4	35.31	4.61	0.18
					55	26.7	36.28	4.92	0.15
					250	13.8	35.77	3.20	1.36
					525	7.1	34.74	3.06	2.38
					1000	5.0	34.93	4.30	2.01
					1500	4.2	35.00	4.94	1.89
					2000	4.1	35.03	4.92	1.85

TABLE 16

STATION DATA, CRUISE P-6803

STA. NO.	DATE 1968	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)	O_2 (ml/l)	PO_4-P (μg-at/l)
4	13 Apr.	0511-0541	25°37'N, 84°10'W	150	surf	24.3	36.29	4.75	0.04
					30	23.0	36.45	4.99	0.32
					100	19.5	36.51	3.74	0.47
5	13 Apr.	1641-1711	27°19'N, 84°10'W	73	surf	21.8	36.50	5.20	0.07
		1731-1801			40	19.5	36.47	5.38	0.10
	15 Apr.	0450-0500	29°10'N, 88°29'W	237	surf	21.0	35.07	5.28	0.14
		0426-0456			40	19.5	36.32	4.87	0.07
					95	18.4	36.22	4.17	0.44
					175*	16.9	36.09	3.21	0.78
11	16 Apr.	1353-1453	25°59'N, 86°11'W	3152	surf	23.3	36.40	4.71	0.16
		1407-1507			30	21.5	36.41	5.01	0.16
					580	7.0	34.80	3.20	2.15
					1030	4.6	34.82	4.43	1.87
					1500	4.2	34.85	4.94	1.75
					2000	4.2	34.84	4.97	1.69

* Hydrographic depth 150 m.

CRUISE P-6803
Continued

STA. NO.	DATE 1968	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)	O_2 (ml/l)	PO_4-P (µg-at/l)
					2500 *	4.3	34.84	5.01	1.67
15	18 Apr.	2212-2312	19°30'N, 87°00'W	1044	surf	26.8	36.06	4.61	0.12
		2222-2322			100	24.0	36.66	4.10	0.22
					200	16.9	36.55	3.56	0.57
					400	12.6	35.59	3.07	1.43
					750	7.4	35.04	3.59	
					995 **	5.1	34.90	4.09	
					1200				
16	21 Apr.	1012-1027	18°10'N, 87°00'W	3837	surf	26.3	35.70	4.63	0.28
		1039-1109			100	25.4	36.39	4.23	0.17
					225	16.9	36.29	3.92	0.75
					420	11.0	35.43	3.14	1.67
					1000	4.6	34.94	4.69	1.76
					1500	4.3	34.96	4.99	1.64
					3000				

* Hydrographic depth 2449 m.
**Hydrographic depth 951 m.

CRUISE P-6803
Continued

STA. NO.	DATE 1968	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)	O_2 (ml/l)	PO_4-P (µg-at/l)
17	22 Apr.	0004-0104	16°40'N, 87°01'W	4146	surf	26.4	35.83	4.28	0.18
		0035-0135			100	23.9	36.71	3.95	0.24
					240	15.1	35.99	3.37	0.97
					490	8.8	35.03	2.88	1.85
					1000	5.0	34.92	4.14	1.96
					2200	4.2	34.97	5.46	1.45
					3000*	4.2	34.98	5.67	1.40
18	22 Apr.	1422-1522	17°18'N, 85°27'W	4866	surf	26.7	36.14	4.57	0.09
		1433-1533			100	25.4	36.37	4.44	0.15
					245	17.4	36.23	3.46	0.87
					480	9.4	35.15	2.86	1.89
					1000	4.9	34.94	4.29	1.84
					1500	4.3	34.99	4.95	1.59
					2150	4.2	35.01	5.37	1.54
		1925-2025			2200	4.2	35.01	5.41	1.54

*Hydrographic depth 2952 m.

CRUISE P-6803
Continued

STA. NO.	DATE 1968	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)	O_2 (ml/l)	PO_4-P (μg-at/l)
					3500	4.2	35.00	5.63	1.58
20	24 Apr.	0046-0122	17°00'N, 82°00'W	1060	surf	27.3	36.22	4.54	0.07
		0102-0138			75	26.3	36.19	4.55	0.10
					125	21.1	36.63	3.50	0.60
					235				
					475				
					740				
22	25 Apr.	0612-0712	20°02'N, 82°48'W	3710	surf	26.4	36.20	4.58	0.23
		0725-0825			100	25.3	36.16	4.64	0.15
					200	22.0	36.86	4.21	
					470	15.3	36.17	3.73	
					890	7.0	35.18	3.80	
					1650	4.3	35.00	5.18	1.58
					3000 *	4.2	35.12	5.62	1.54

*Hydrographic depth 2949 m.

CRUISE P-6803
Continued

STA. NO.	DATE 1968	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)	O_2 (ml/l)	PO_4-P (µg-at/l)
25	27 Apr.	0240-0310	23°00'N, 84°59'W	1975	surf	27.1	36.13	4.63	0.16
		0249-0319			100	24.9	36.23	4.20	0.20
					250	19.8	36.56	3.52	0.61
		0356-0426			500	12.9	35.65	3.14	1.38
					750	9.3	35.26	3.23	1.76
					1000	6.1	34.91	3.39	2.09
					1425	4.4	34.98	4.71	1.78
26	27 Apr.	1503-1620	23°30'N, 83°30'W	2170	surf	26.6	36.20	4.60	0.14
		1524-1627			100	25.1	36.37	4.40	0.17
					150	21.9	36.79	3.72	0.28
					480	11.8	35.44	3.09	1.55
					750	8.2	35.14	3.47	1.81
					1000	5.3	34.91	3.87	1.99

TABLE 17

STATION DATA CRUISE P-6805

STA. NO.	DATE 1968	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
2	15 June	0030-0130	21°36'N, 86°00'W	1740	surf	28.2	36.14
		0044-0130			100	24.2	36.71
					250	17.7	36.49
					440	12.1	35.57
					715	6.6	34.94
					1000	4.9	35.02
					1500	4.3	35.07
3	15,16 June	2305-0005	19°59'N, 84°20'W	4347	surf	27.8	35.99
		2326-0026			100	25.4	36.50
					250	18.2	36.59
					500	12.4	35.62
					1040	4.9	35.02
					1583*	4.3	35.07
					2250		
	16 June	0335-0435			2400		
					3750		
4	17 June	0739-0839	19°02'N, 80°20'W	5700	surf	28.2	36.13
		0803-0903			90	25.3	36.44
					250	18.4	36.63
					500	13.0	35.73
					1010	5.1	35.00

*Hydrographic depth 1500 m.

CRUISE P-6805
Continued

STA. NO.	DATE 1968	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
					1500	4.3	35.07
					2000		
		1554-1654			2323		
					3350		
					4000		
5	19 June	0215-0315	17°23'N, 77°37'W	1058	surf	28.1	36.15
		0139-0239			96	25.3	36.55
					250	18.5	36.59
					340	15.8	36.19
					500	11.6	35.49
					770		
7	20 June	1210-1310	15°51'N, 75°02'W	3003	surf	28.0	36.48
		1227-1327			50	26.2	36.58
					500	9.4	35.12
					1000	4.7	34.96
					1500	4.1	35.00
					2300		
					2650		
9	22 June	0400-0500	15°10'N, 70°45'W	4233	surf	28.0	35.99
		0415-0515			65	27.0	36.15
					250	16.8	36.30

STA. NO.	DATE 1968	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
					500	9.4	35.05
					981	5.2	34.91
					1438	4.2	35.00
					2026		
10	23 June	0250-0350	14°32'N, 68°11'W	4825	surf	27.9	35.98
		0307-0407			55	25.6	36.63
					245	15.0	35.92
					477	9.4	35.08
					995	4.9	34.94
					1500	4.2	34.99
					2256		
		0620-0720			2500		
11	24 June	0045-0145	14°00'N, 66°10'W	4975	surf	27.9	35.51
		0052-0152			250	16.4	36.13
					537	9.1	34.97
					1050	5.1	34.87
					1700		
					2263		
		0434-0534			2550		
					3200		
					4517		

TABLE 18

STATION DATA CRUISE P-6811

STA. NO.	DATE 1968	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
1	4 Nov.	0450-0550	19°41'N, 74°05'W	3180	surf	28.8	35.75
		0506-0606			38	29.0	36.26
					250	18.3	36.50
					500	13.2	35.70
					750	8.1	35.07
					950	5.9	34.95
					1380	4.5	35.01
		0932-1032			2025		
2	5 Nov.	0228-0328	18°05'N, 75°25'W	2529	surf	28.5	35.14
		0238-0338			77	27.4	36.16
					237	19.2	36.56
					508	11.6	35.39
					822	6.5	34.86
					1000	5.3	34.91
					1200	4.5	34.95
3	5 Nov.	1925-2025	16°10'N, 76°12'W	2103	surf	28.4	35.33
		2045-2145			63	28.3	35.55
		1832-1932			225	19.7	36.57
		2045-2145			500	11.4	35.32
		1832-1932			770	7.0	34.80
					1450	4.3	34.96
					1800		

STA. NO.	DATE 1968	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
4	6 Nov.	1328-1428	14° 10'N, 76° 34'W	3950	surf	28.1	35.48
		1345-1445			50	27.5	36.16
					270	16.2	36.10
					550	8.9	34.98
					1050	5.2	34.88
					1800		
					2150		
		1714-1814			2312		
					3000		
					3250		
5	7 Nov.	1138-1238	11° 46'N, 76° 50'W	3375	surf	28.2	35.79
		1155-1255			25	26.4	36.19
					250	14.7	35.82
					500	8.4	34.97
					750	6.2	34.79
					1016	4.9	34.90
		1528-1628			1823		
					2450		
					2850		
6	8 Nov.	0607-0707	09° 47'N, 77° 04'W	2950	surf	28.8	35.54
		0621-0721			25	28.6	35.90

CRUISE P-6811
Continued

STA. NO.	DATE 1968	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
					250	16.0	36.05
					485	8.9	34.97
					720	6.4	34.78
					1000	4.9	34.90
		1011-1111			1750		
					2025		
					2525		
7	8 Nov.	1945-2045	08°56'N, 77°07'W	832	surf	28.9	33.93
		1943-2043			90	25.6	36.38
					125	22.3	36.63
					225	16.4	36.11
					275	14.4	35.76
					375	11.0	35.26
					500	8.5	34.92
8	9 Nov.	1055-1155	10°29'N, 78°40'W	3008	surf	28.0	34.96
		1111-1211			27	28.3	35.92
					238	16.1	36.09
					480	9.1	34.99
					713	7.2	34.80
					1000	5.1	34.88
					1500	4.3	34.96

CRUISE P-6811
Continued

STA. NO.	DATE 1968	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
		1408-1508			2000		
					2450		
9	10 Nov.	0842-0942	10°25'N, 80°55'W	3246	surf	27.7	34.85
		0833-0933			50	21.7	36.63
					230	13.5	35.61
					450	8.3	34.90
					635	6.8	34.78
					875	5.4	34.85
					1400	4.3	34.95
		1155-1255			1525*	4.2	34.96
					2350		
10	11 Nov.	0305-0405	10°23'N, 82°38'W	1708	surf	28.1	35.37
		0317-0417			25	28.1	36.11
					250	14.1	35.70
					500	8.1	34.87
		0503-0603			750	6.1	34.80
					900	5.2	34.87
					1000	4.8	34.90
11	12 Nov.	0135-0235	12°48'N, 81°46'W	1948	surf	29.1	36.04
		0203-0303			45	27.3	36.20
					285	13.8	35.62

*Hydrographic depth 1500 m.

C R U I S E P-6811
Continued

STA. NO.	DATE 1968	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
					590	8.1	34.90
					800	6.0	34.80
					1200	4.5	34.94
					1400	4.3	34.95
12	12 Nov.	1632-1732	14° 50'N, 80° 45'W	1189	surf	28.3	35.74
		1810-1910			35	28.3	35.80
		1646-1716			160	18.1	36.39
					290	14.1	35.72
					550	8.4	34.90
					775		
					1100		
14	14 Nov.	1600-1700	18°15'N, 79°20'W	4023	surf	28.1	35.62
		1459-1559			40	28.2	35.67
					285	17.5	36.38
					590	10.3	35.26
					800	6.2	34.83
					1175	4.5	34.94
					1700		
		1942-2042			1875		
					2375		
					2850		

CRUISE P-6811
Continued

STA. NO.	DATE 1968	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
15	15 Nov.	1135-1235	20°04'N, 79°38'W	2578	surf	27.8	35.84
		1142-1242			55	27.8	35.84
					237	19.2	36.58
					470	14.5	35.85
		1508-1608			1000	5.1	34.89
					1325	4.3	34.95
		1142-1242			1500	4.2	34.97
					1950		
16	16 Nov.	0335-0435	20°24'N, 81°04'W	3063	surf	27.8	36.03
		0351-0451			52	27.7	36.04
					250	18.7	36.52
					500	13.0	35.63
					750	7.7	34.91
					1000	5.0	34.90
					1500	4.2	34.97
		0701-0801			1875		
					2150		
					2550		
17	16 Nov.	1851-1951	20°24'N, 82°35'W	4334	surf	27.8	36.05
		1909-2009			85	26.8	36.23
					237	18.7	36.50

C R U I S E P-6811
Continued

STA. NO.	DATE 1968	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
					485	12.6	35.54
					714	7.7	34.87
					1000	5.1	34.89
					1500	4.2	34.97
		2236-2336			1950		
					2375		
					3500		
18	17 Nov.	0958-1058	19°54'N, 84°14'W	4410	surf	27.7	36.06
		1014-1114			114	27.8	36.07
					260	19.8	36.54
					525	12.7	35.53
					763	7.1	34.83
					1050	4.8	34.91
					1500	4.2	34.96
		1321-1421			1900		
					2500		
					3500		
19	18 Nov.	0442-0542	19°57'N, 86°20'W	3420	surf	27.9	36.04
		0500-0600			75	27.7	36.11
					320	16.4	36.13
					700	7.5	34.86

STA. NO.	DATE 1968	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
					800	6.4	34.81
					1250	4.4	34.94
					1500	4.2	34.96
		0747-0847			1625		
					1850		
					2350		
20	18 Nov.	2120-2220	21°40'N, 85°40'W	1994	surf	28.0	36.11
		2136-2236			75	27.7	36.14
					250	19.0	36.51
					500	11.8	35.41
					750	7.4	34.84
					1000	5.1	34.89

TABLE 19

STATION DATA CRUISE P-6904

STA. NO.	DATE 1969	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
1	12 Apr.	0355-0455	23°29'N, 84°08'W	2522	surf	26.3	36.01
		0408-0508			38	25.3	36.19
					215	17.0	36.24
					415	11.7	35.42
					795	5.8	34.88
					1125	4.6	34.94
					1450	4.2	34.97
2	12 Apr.	2253-2353	21°43'N, 86°06'W	1724	surf	27.7	36.04
	12,13 Apr.	2310-0010			14	27.3	36.01
	13 Apr.	0114-0214			265	15.6	36.05
					500	9.5	35.10
					1150	4.5	34.95
3	13 Apr.	1910-2010	20°07'N, 86°22'W	2544	surf	27.3	35.84
		1911-2011			30	27.0	35.99
					265	16.0	36.17
					550	8.7	35.05
					800	5.7	34.91
					1050	4.6	35.00
					1700		
	13,14 Apr.	2358-0058	19°55'N, 86°11'W	4410	2000		
					2250		

C R U I S E P-6904
Continued

STA. NO.	DATE 1969	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
					3000		
4	14 Apr.	1545-1645	19°54'N, 84°14'W	4410	surf	27.2	36.01
		1605-1705			30	26.8	35.97
					230	19.6	36.65
					470	13.5	35.73
					950	5.9	34.88
					1400	4.4	34.99
					1925		
		2040-2140			2380		
					3410		
					3560		
5	15 Apr.	2000-2100	18°45'N, 82°10'W	4712	surf	27.7	35.95
		1544-1644			21	26.7	35.97
					250	17.5	36.38
					500	11.1	35.34
					1033	4.7	34.96
					1534 *	4.3	35.01
					2000		
		1959-2059			2620		
					3655		
					4105		

*Hydrographic depth 1500 m.

CRUISE P-6904
Continued

STA. NO.	DATE 1969	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
6	17 Apr.	0119-0219	19°07'N, 80°27'W	6600	surf	27.8	35.80
		0131-0231			31	27.4	35.75
					232	20.2	36.71
					418	14.5	35.88
					1000	5.4	34.91
					1500	4.3	35.01
					2042		
	16 Apr.	1351-1451			2575		
					3144		
					3594		
	17 Apr.	0751-0851			4000		
					5000		
					6000		
7	18 Apr.	0148-0248	18°12'N, 78°34'W	2379	surf	28.1	35.88
		0125-0225			25	27.7	36.05
					241	18.8	36.59
		0300-0400			452	13.9	35.80
					737	7.1	34.90
					918	5.4	34.91
					1404	4.3	35.00
9	20 Apr.	2234-2334	17°13'N, 75°54'W	1473	surf	27.9	36.06

C R U I S E   P-6904
Continued

STA. NO.	DATE 1969	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
		2218-2318			70	25.7	36.16
					236	18.7	36.60
					467	12.8	35.62
					676	8.3	35.04
					1000	5.2	34.95
10	21 Apr.	1418-1518	15°51'N, 75°00'W	2966	surf	27.8	35.81
		1434-1540			30	27.7	35.88
					233	18.3	36.52
		1615-1717			455	12.6	35.61
					663	7.9	34.99
					981	5.0	34.94
					1484	4.2	35.00
		1939-2038			1665		
					1892		
					2394		
11	22 Apr.	1000-1100	17°38'N, 74°59'W	1376	surf	28.1	35.91
		1006-1106			45	27.3	35.92
					262	17.4	36.36
					524	11.9	35.48
					759	7.9	35.01
					1036	4.8	34.97

CRUISE P-6904
Continued

STA. NO.	DATE 1969	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
12	22 Apr.	2025-2125	18°47'N, 75°23'W	2040	surf	28.2	35.95
		2039-2139			30	27.3	35.90
					259	18.1	36.48
					515	12.3	35.57
					781	7.5	35.02
					1036	5.0	34.97
13	23 Apr.	0410-0510	19°24'N, 75°30'W	4377	surf	27.7	36.03
		0426-0526			48	26.2	36.21
					258	18.8	36.62
					524	13.8	35.84
					753	8.6	35.15
					1019	5.2	34.99
					1638		
		0814-0914			2115		
					2612		
					3474		
14	23 Apr.	2027-2127	19°40'N, 74°05'W	3307	surf	27.7	35.92
		2036-2145			37	26.0	36.37
					239	17.9	36.48
					458	13.2	35.74
					734	8.7	35.17

CRUISE P-6904
Continued

STA. NO.	DATE 1969	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
					1052	5.0	34.98
	23,24 Apr.	2318-0020			1454	4.4	35.03
					1828		
					2336		
15	24 Apr.	1430-1530	20°21'N, 72°19'W	3816	surf	26.8	36.36
		1448-1550			52	23.5	36.76
					261	18.1	36.55
					524	12.9	35.70
		2048-2159			791	7.7	35.09
		1448-1550			1057	5.2	35.04
					1500	4.0	35.02
		2048-2159			1816		
					2248		
					3288		
16	25 Apr.	1235-1335	20°36'N, 71°02'W	1848	surf	27.2	36.32
		1005-1100			59	24.5	36.65
					253	18.3	36.57
					519	14.0	35.85
		1235-1335			761	8.6	35.14
					974	6.0	35.06
					1500	4.0	35.04

C R U I S E P-6904
Continued

STA. NO.	DATE 1969	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
17	26 Apr.	0140-0240	21°05'N, 72°36'W	3988	surf	27.8	36.22
		0152-0253			45	24.5	36.69
					251	18.2	36.57
					750	8.5	35.13
					971	6.0	35.05
					1408	4.1	35.02
18	26 Apr.	1302-1402	20°37'N, 73°22'W	3541	surf	27.0	36.30
		1315-1418			62	23.8	36.74
					261	18.5	36.60
					531	14.1	35.88
					802	8.5	35.15
					1033	5.7	35.06
					1532*	4.1	35.03
		1827-1927			1747		
					1942		
					2540		
19	27 Apr.	1355-1455	21°20'N, 74°58'W	2727	surf	26.0	36.40
		1232-1341			30	24.8	36.44
					274	18.1	36.55
					550	14.0	35.87
					904	6.7	35.06

*Hydrographic depth 1500 m.

CRUISE P-6904
Continued

STA. NO.	DATE 1969	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
					1248	4.6	35.04
		0923-1023			1583		
					1986		
					2524		
20	28 Apr.	0012-0112	21°45'N, 76°09'W	2325	surf	26.1	36.24
		0021-0121			10	26.0	36.24
					258	18.2	36.55
					537	14.1	35.87
					827	7.5	35.08
					1052	5.4	35.06
					1588		
21	29 Apr.	0145-0245	24°00'N, 79°28'W	558	surf	26.0	36.26
		0147-0248			50	24.8	36.36
					220	19.3	36.63
					297	16.5	36.28
					431	13.7	35.80
					490	12.9	35.71
22	29 Apr.	1220-1320	24°14'N, 80°28'W	971	surf	26.3	36.08
		1240-1340			40	25.6	36.19
					252	16.8	36.28
					372	13.9	35.79

CRUISE P-6904
Continued

STA. NO.	DATE 1969	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
					450	12.7	35.61
					554	9.4	35.11
					620*	8.2	35.01

*Hydrographic depth 600 m.

TABLE 20

STATION DATA CRUISE P-6911

STA. NO.	DATE 1969	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
1	26 Oct.	0206-0306	18°00'N, 64°44'W	3008	surf	28.9	35.27
		0221-0321			65	27.5	36.26
					250	18.2	36.54
		0604-0704			459	13.6	35.72
					715	7.2	34.87
					911	5.8	34.92
					1371	4.4	34.99
					1835		
					2337		
2	27 Oct.	0030-0130	16°20'N, 63°10'W	1483	surf	29.1	34.31
		0034-0134			53	27.3	36.25
					242	16.6	36.16
					533	9.6	35.10
					844	5.9	34.76
					1272		
3	27 Oct.	1407-1507	15°00'N, 62°00'W	2660	surf	28.8	34.49
		1419-1519			60	27.1	36.36
					274	14.4	35.83
		1823-1923			494	8.5	34.91
		1419-1519			739	6.4	34.73
					1040	5.2	34.88

CRUISE P-6911
Continued

STA. NO.	DATE 1969	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
		1823-1923			1567		
					2072		
					2556		
4	28 Oct.	0335-0434	14°15'N, 61°40'W	2853	surf	28.9	34.47
		0350-0450			81	27.9	36.17
					218	15.5	35.97
					423	9.9	35.11
					836	5.7	34.79
					1338	4.2	34.96
					1844		
5	28 Oct.	1203-1303	13°30'N, 61°30'W	2727	surf	28.8	34.57
		1217-1317			59	27.5	35.88
					237	14.6	35.79
					472	8.2	34.79
					698	6.1	34.69
					996	4.7	34.91
		1545-1645			1878		
					2474		
6	29 Oct.	0344-0444	13°30'N, 62°50'W	1656	surf	28.8	32.71
					50	28.3	35.35
					240	13.5	35.60

C R U I S E P-6911
Continued

STA. NO.	DATE 1969	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
					481	8.5	34.90
					665	6.3	34.71
					888	5.4	34.80
					1324	4.2	34.96
7	29 Oct.	1930-2030	15°01'N, 64°32'W	3365	surf	29.2	34.80
		1947-2047			60	28.1	35.79
					253	15.8	36.10
					539	8.5	34.90
					779	5.9	34.76
					1000	5.1	34.90
	29,30 Oct.	2343-0051			1300	4.3	34.95
8	30 Oct.	1615-1715	16°40'N, 66°15'W	4334	surf	29.0	34.16
		1634-1734			60	28.3	35.95
					243	18.6	36.51
					510	10.4	35.21
					995	5.0	34.91
					1548*	4.1	34.96
					2088		
		2027-2127			2316		
					3304		
					3942		

*Hydrographic depth 1500 m.

C R U I S E   P-6911
Continued

STA. NO.	DATE 1969	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
9	31 Oct.	0927-1027	16°42'N, 67°57'W	4529	surf	29.2	34.48
		0946-1046			60	28.8	35.58
					250	18.0	36.37
					515	10.6	35.24
					1006	5.3	34.89
					1580 *	4.2	34.97
					2088		
		1406-1506			2454		
					3442		
					3910		
10	1 Nov.	0613-0713	16°48'N, 70°04'W	3861	surf	29.1	35.04
		0634-0734			56	28.6	35.55
					227	17.1	36.29
					480	10.6	35.22
					975	5.4	34.89
					1500	4.2	34.97
					2032		
		1227-1327			2118		
					2660		
					3176		
11	1 Nov.	2131-2231	17°30'N, 69°30'W	4191	surf	29.1	34.42

*Hydrographic depth 1500 m.

STA. NO.	DATE 1969	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
		2151-2251			58	29.1	35.30
					234	17.7	36.45
					491	10.6	35.20
					969	5.7	34.84
					1570*	4.2	34.97
					2104		
	2 Nov.	0203-0303			2490		
					3602		
					4096		
12	2 Nov.	1552-1652	18°20'N, 68°00'W	481	surf	29.0	34.26
		1556-1656			36	29.2	34.80
					78	25.9	36.43
					153	21.4	36.79
					200	18.7	36.55
					258	17.1	36.32
		1823-1923			296	16.6	36.24
					344	15.6	36.08
					410	14.3	35.86
					465**	13.4	35.78
13	3 Nov.	0510-0610	19°15'N, 67°15'W	6716	surf	29.3	34.27
		0523-0623			65	27.3	36.26

* Hydrographic depth 1500 m.

**Hydrographic depth 426 m.

CRUISE P-6911
Continued

STA. NO.	DATE 1969	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
					269	17.9	36.49
					500	12.8	35.62
					1036	5.8	34.99
					1601		
					2232		
		0925-1025			2862		
					5200		
14	4 Nov.	0030-0130	19°02'N, 65°38'W	4149	surf	29.2	35.60
		0046-0146			34	28.8	35.92
					265	18.0	36.52
					520	12.0	35.48
					785	7.3	34.90
					954	6.2	34.97
					1443	4.2	35.00
15	6 Nov.	1153-1253	19°35'N, 67°14'W	7970	surf	28.7	34.44
		1211-1311			53	28.3	35.99
					224	19.1	36.64
					445	15.0	36.00
					970	6.3	34.96
					1424	4.3	35.01
					1998	3.6	35.00

C R U I S E P-6911
Continued

STA. NO.	DATE 1969	TIME (GMT)	LOCATION	BOTTOM DEPTH (m)	FISHING DEPTH (m)	TEMP. (°C)	SALINITY (‰)
		1703-1803			2950	3.0	34.98
					3932	2.4	34.94
	7 Nov.	0921-1021			4556	2.4	34.93
	6 Nov.	1703-1803			6220 *	2.0	34.89
	7 Nov.	0921-1021			7000 **		
					7500 **		
16	9 Nov.	0108-0208	20°28'N, 72°30'W	4035	surf	28.3	36.13
		0128-0228			51	27.6	36.38
					243	18.1	36.51
					478	14.5	35.90
					1012	5.6	35.01
					1525 ***	4.0	34.97
					2032		
17	9 Nov.	1906-2006	21°08'N, 74°42'W	2750	surf	28.3	36.23
		1925-2025			54	26.7	36.40
					261	18.3	36.54
					514	14.6	35.92
					1039	5.5	35.02
					1590 ***	4.0	34.99
					2216		

* Thermometric depth
** See Table 1 for data on temperature, salinity and oxygen.
*** Hydrographic depth 1500 m.

BIOLOGICAL DATA

Introduction

The sampling method was described in detail by Owre & Low (1969) and Owre & Foyo (1972). Modified "Discovery" nets were used with mechanically actuated opening-closing mechanisms (General Oceanics, Inc.). The nets are 3.5 m long, consisting of three grades of nylon mesh, with a mouth opening 75 cm in diameter and a cod-end opening 10 cm in diameter. The sizes of mesh, commencing with the cod end, are approximately 100μm (Nitex number 110), 1.6 mm and 3.2 mm. These nets were used on all cruises after P 6602. At each station, the objective was to obtain a complete set of samples, spaced at intervals from the surface to a depth near bottom. The nets were sent down to the desired depths tightly rolled, opened at depth to fish for one hour, closed and retrieved. In water 2000-2500 m deep, six nets were put on the wire, the deeper ones spaced to fish 500-1000 m apart, the shallower ones 250 m apart and the shallowest, in the lower Tropical Surface Water or upper Subtropical Underwater near the thermocline, if present. A surface net fished simultaneously, suspended from a boom and independent of the wire. Depths greater than 2000-2500 m were sampled in separate three-net casts. For example, Station 8, P 6911, bottom depth 4334 m (Table 20), was sampled in two casts with the nets set to fish at 0, 60 (thermocline), 250, 500, 1000, 1500 and 2000 m in the first cast, and 2500, 3500 and 4000 m in the second. The figure recorded as the fishing depth for each net, however, is the average depth registered by the Benthos Time-Depth Recorder during the hour-long tow; thus, the depths given in the table are 0, 60, 243, 510, 995, 1548, 2088, 2316, 3304 and 3942 m. The only deviations from this basic plan were caused by occasional trouble with the first cast which necessitated setting it again and used time which otherwise would

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JUN 76 H B MICHEL, M FOYO, D A HAAGENSEN N00014-67-A-0201-0013

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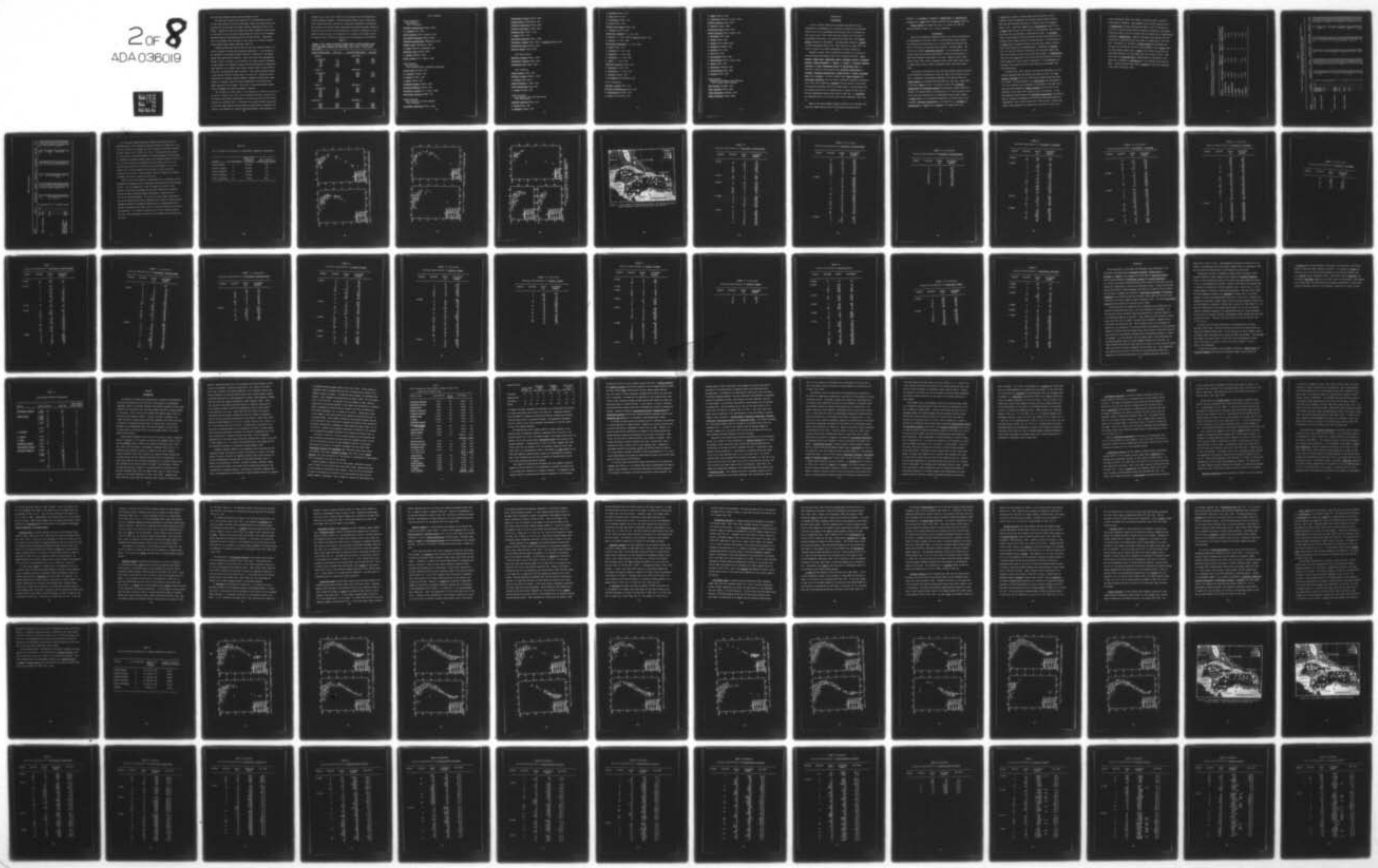

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have been spent making a second cast and perhaps a third.

To insure that a surface wire angle of 45° was maintained both while the nets were being put on the wire and while towing, the bridge officer was provided with an electronic wire angle indicator, described by Owre & Low (1969). Hundreds of records of surface wire angles combined with the meters of wire payed out and the actual fishing depths as traced by the Time-Depth Recorders produced increasing accuracy in setting the nets. Using these, Owre & Low tabulated data on meters of wire to pay out to achieve selected fishing depths under similar conditions (Table 21).

Plankton samples were fixed as soon as they were received on deck in 10 percent formalin, buffered with hexamethylenetetramine. In the laboratory all specimens of the selected species (see List of Species) in the smaller samples were identified and counted. Larger collections were subsampled by aliquot, usually one-tenth to one-fiftieth of the total volume of specimens. In some samples, all specimens of groups such as heteropods and chaetognaths, which might be low in number, were counted, whereas counts of more numerous forms such as copepods were made by aliquot. This yielded estimated numbers of each species filtered from the water in an hour tow. Though the values obtained do not represent absolute numbers of animals filtered from a known quantity of seawater, they are strictly comparable at the locations and depths reported for all cruises. They serve to show distributional ranges, areas of abundance and relative abundance of species.

The estimated or actual numbers of each species per standard hour-long tow are given in Tables 25-32, 35-57, 62-79, 86-101 and 104-106, and these, with the chemical and physical measurements and station locations in Tables 13-20, comprise the biological data. To interpret the relation between distribution of the more common species and water masses as identified by temperature and salinity, the abundance of a species was plotted against these parameters in

diagrams (e.g., Figs. 11-17), known in the literature as T-S-P (Temperature-Salinity-Plankton) diagrams. The more numerous species, many of them epipelagic, having often been collected at a particular combination of temperature and salinity, the circular symbol representing the greatest abundance among the records was used in cases of such coincidence, instead of attempting to draw a symbol for each of them. The locations of all stations of the eight cruises are shown in Figs. 9 and 10 for reference in the discussions of distribution.

TABLE 21

Summary of Wire Lengths and Desired Fishing Depths in Making Plankton Tows. (0-1000 m, using 5 nets; 0-1500 and 0-2000, with 6 nets; 1500-2500, 2000-3500, 2500-3500, 2500-4000, and 4000-6000 m, with 3 nets). (From Owre & Low, 1969).

Desired fishing depth	Wire (m)	Desired fishing depth	Wire (m)
0-1000 m		2000-3500 m	
thermocline	----	2000	2580
250	375	2500	3170
500	775	3500	4335
750	1162		
1000	1550		
0-1500 m		2500-3500 m	
thermocline	----	2500	3170
250	375	3000	3750
500	775	3500	4335
750	1162		
1000	1500		
1500	2070		
0-2000 m		2500-4000 m	
thermocline	----	2500	3170
250	355	3500	4305
500	709	4000	4880
1000	1410		
1500	2070		
2000	2680		
1500-2500 m		4000-6000 m	
1500	1965	4000	4930
2000	2600	5000	6030
2500	3225	6000	7080

List of Species

Phylum Coelenterata
Class Hydrozoa
Order Siphonophora

Abylopsis eschscholtzii (Huxley, 1859)

A. tetragona (Otto, 1823)

Bassia bassensis (Quoy & Gaimard, 1834)

Ceratocymba leuckartii (Huxley, 1859)

Chelophyes appendiculata (Eschscholtz, 1829)

Diphyes bojani (Eschscholtz, 1829)

D. dispar Chamisso & Eysenhardt, 1821

Eudoxoides mitra (Huxley, 1859)

E. spiralis (Bigelow, 1911)

Porpita umbella (O. F. Müller, 1776)

Phylum Mollusca
Class Gastropoda
Order Mesogastropoda, Superfamily Heteropoda

Atlanta fusca Souleyet, 1852

A. inclinata Souleyet, 1852

A. inflata Souleyet, 1852

A. peroni Lesueur, 1817

Cardiapoda placenta (Lesson, 1830)

Firoloida desmaresti Lesueur, 1817

Protatlanta souleyeti (E. A. Smith, 1888)

Pterotrachea coronata Forskål, 1775

Phylum Arthropoda
Class Crustacea, Sub-class Copepoda
Order Calanoida

Acrocalanus longicornis Giesbr., 1888

Clausocalanus furcatus (Brady, 1883)

Euchaeta marina (Prestandrea, 1833)

Haloptilus longicornis (Claus, 1863)

Lucicutia flavicornis (Claus, 1863)

Mormonilla minor Giesbr., 1891

M. phasma Giesbr. 1891

Paracalanus aculeatus Giesbr., 1888

Rhincalanus cornutus (Dana, 1852) f. atlantica Schmaus, 1917

Scolecithrix danae (Lubbock, 1856)

Undinula vulgaris (Dana, 1852)

Order Harpacticoida

Aegisthus aculeatus Giesbr., 1891

Macrosetella gracilis (Dana, 1848)

Microsetella rosea (Dana, 1848)

Order Cyclopoida

Conaea gracilis (Dana, 1853)

Farranula carinata (Giesbr., 1891)

F. gracilis (Dana, 1853)

Oithona plumifera W. Baird, 1843

Oncaea mediterranea Claus, 1863

O. venusta Philippi, 1843

Phylum Arthropoda
Class Crustacea, Sub-class Malacostraca
Order Euphausiacea

Euphausia americana Hansen, 1911

E. brevis Hansen, 1905

E. gibboides Ortmann, 1893

E. hemigibba Hansen, 1910

E. mutica Hansen, 1905

E. pseudogibba Ortmann, 1893

E. tenera Hansen, 1905

Nematobrachion boopis Calman, 1896

N. flexipes (Ortmann, 1893)

Nematoscelis megalops G. O. Sars, 1885

N. microps G. O. Sars, 1883/N. atlantica Hansen, 1910

N. tenella G. O. Sars, 1883

Stylocheiron abbreviatum G. O. Sars, 1883

S. affine Hansen, 1910

S. carinatum G. O. Sars, 1883

S. elongatum G. O. Sars, 1883

S. longicorne G. O. Sars, 1883

S. suhmii G. O. Sars, 1883

Thysanopoda aequalis Hansen, 1905

T. monacantha Ortmann, 1893

T. obtusifrons G. O. Sars, 1883

T. pectinata Ortmann, 1893

T. tricuspidata Milne-Edwards, 1830

Phylum Chaetognatha

Bathybelos typhlops Owre, 1973

Eukrohnia bathyantarctica David, 1958

E. bathypelagica Alvariño, 1962

E. fowleri Ritter-Záhony, 1909

E. hamata (Möbius, 1875)

E. proboscidea Furnestin & Ducret, 1965

Krohnitta pacifica (Aida, 1897)

K. subtilis (Grassi, 1881)

Pterosagitta draco (Krohn, 1853)

Sagitta bipunctata Quoy & Gaimard, 1827

S. decipiens Fowler, 1905

S. enflata Grassi, 1881

S. helenae Ritter-Záhony, 1910

S. hexaptera d'Orbigny, 1843

S. hispida Conant, 1895

S. lyra Krohn, 1853

S. macrocephala Fowler, 1905

S. megalopthalma Dallot & Ducret, 1969

S. minima Grassi, 1881

S. planctonis Steinhaus, 1896

S. serratodentata Krohn, 1853

S. zetesios Fowler, 1905

Phylum Chordata
Sub-phylum Urochordata, Class Thaliacea
Order Salpida, Family Salpidae

Ihlea punctata (Forskål, 1775)

Salpa fusiformis Cuvier, 1804

Thalia democratica (Forskål, 1775)

Weelia cylindrica (Cuvier, 1804)

Siphonophora

Introduction

In 1971, Alvariño reviewed the world-wide distribution of the Siphonophora, and Björnberg, the occurrence of species in the Caribbean. Previous work in the southwestern North Atlantic and the Caribbean was also cited by Owre & Foyo (1972) when they reported the collection of nine species in the area. The same nine are listed here, with Porpita umbella included for convenience. Some specialists classify P. umbella in Order Chondrophora (Hand, 1972), while others (e.g., Pugh, 1974) continue to include it in Order Siphonophora, Sub-order Cystonectae.

Recently, Alvariño (1974) recorded the occurrence of 20 species in various oblique and horizontal tows from the western Caribbean: Abyla haeckeli, Agalma okeni, Amphicaryon acaule, Chelophyes contorta, Enneagonum hyalinum, Lensia challengeri, L. fowleri, L. hotspur, L. subtilis, Muggiaea atlantica, M. kochi, Stephanomia bijuga and Sulculeolaria chuni, in addition to seven of those reported here, Abylopsis eschscholtzii, A. tetragona, Chelophyes appendiculata, Diphyes bojani, D. dispar, Eudoxoides mitra and E. spiralis. Our most uncommon forms, Bassia bassensis and Ceratocymba leuckartii, were not found in Alvariño's Caribbean collections. Owre & Foyo (1972) reported B. bassensis from the surface at one station in the eastern Caribbean, and in the present study, it was collected from the surface and at 103 m at a station south of Jamaica (P 6606, Sta. 4), the only siphonophore species found there at that time. C. leuckartii was collected once, at 25 m in the south central Caribbean (P 6811, Sta. 5).

Based on the total estimated numbers collected at all stations, the seven more common species rank in the following declining order of

abundance: A. tetragona, D. bojani, A. eschscholtzii, C. appendiculata, E. mitra and D. dispar almost equally numerous, and E. spiralis (Table 22).

Porpita umbella was caught only once, in a surface tow from the central Caribbean (P 6811, Sta. 4, seven juveniles).

Distribution

Pugh (1974) published an important study on the vertical distribution of siphonophores in the upper 1000 m off Fuerteventura, Canary Islands. In horizontal and oblique hauls with a 10-foot IKMT and horizontal tows with a 1 m^2 ring net, 64 species were collected. Few were common. The list did not include Ceratocymba leuckartii. In his discussion of each species, Pugh cited previous observations on vertical distribution, of which the following are pertinent to our work: Bigelow & Sears (1937), Leloup (1933, 1934), Leloup & Hentschel (1935), Moore (1949, 1953), Moore & Corwin (1956), Patriti (1970), Stepanyants (1967), and Totton (1954, 1965).

The vertical distribution of the seven more numerous species collected in the Caribbean is summarized in Table 22; Tables 25-31 contain the raw data. Although all are primarily epipelagic, each species except for Diphyes dispar was collected well below 200 m at least once. Pugh (1974) collected D. dispar at 780 m. The record of 2500 m for Chelophyes appendiculata and Eudoxoides spiralis is particularly unusual (Table 22). However, the maximum number of each species, i.e., over 90 percent of the total catch, was collected over a comparatively narrow range of depth. D. dispar appears to be essentially restricted to surface waters in the Caribbean, Abylopsis eschscholtzii to the upper 50 m, A. tetragona, C. appendiculata, D. bojani and E. spiralis to the upper 100 m, and

E. mitra may be common at various depths from the surface to 250 m. Primarily, they are organisms of the highly variable Tropical Surface Water and the Subtropical Underwater, as shown in the T-S-P diagrams (Figs. 11-13). These data suggest that A. eschscholtzii (Fig. 13A) and D. dispar (Fig. 13B) may be more tolerant of low salinities than the other species and also stenothermal in comparison with them. A. tetragona (Fig. 11A) was numerous in both warm layers and also was collected in the boundary layers between warm and cold water spheres. The distribution of D. bojani (Fig. 12A) appeared linked to the warm water sphere, with one record from Subantarctic Intermediate Water. Similarly, E. spiralis (Fig. 13C) was most frequently collected in the warm water sphere, and there were isolated records from the SAIW and the NADW. C. appendiculata (Fig. 11B) and E. mitra (Fig. 12B) were the only species found to be relatively common over a broad range of temperature. The hydrographic and biological data reported by Owre & Foyo (1972) are in agreement with these observations.

Although Pugh's (1974) material was collected differently, his conclusions regarding these few species are similar to ours. He caught Abylopsis tetragona at 615 m but found that it mainly lives quite near the surface. The few specimens of A. eschscholtzii came from depths of 50 to 410 m whereas in the Caribbean it was numerous in the upper 50 m. Pugh found most specimens of Bassia bassensis, which is rare in the Caribbean, in the upper 100 m, usually close to the surface. It has been reported by many authors that Chelophyes appendiculata, described by Pugh as "probably the commonest and most widely distributed species of siphonophore," has a broad vertical distribution as well. Sources have found it most numerous in the upper 100 m, as we did, or 200 m, and

Leloup & Hentschel (1935), who caught it as deep as 1000 m, reported a second peak at 400-600 m. Pugh commented that the main concentration of C. appendiculata occurred just below the depth of the 15°C isotherm, at 14.4-14.5°C, and that Moore (1953) had reported a significant correlation between the depth of the 15°C isotherm and the distribution of siphonophores, including C. appendiculata. However, the present data indicate that this species has a broad distribution with regard to temperature in the Caribbean. The majority of specimens of Diphyes dispar were collected from the upper 50 m by Pugh as they were in the Caribbean, but D. bojani, which has found somewhat deeper than D. dispar in the latter area and was the second most numerous form, was caught only once by Pugh, at 800 m. Pugh also noted that Eudoxoides mitra, although mainly an inhabitant of the upper 150 m, resembles C. appendiculata in its relatively broad vertical range. Authors generally agree that E. spiralis is found most frequently in the upper 100 m (Pugh, 1974).

TABLE 22

Relative abundance and vertical distribution of siphonophores collected in the Caribbean Sea and adjacent areas.

Species	Depth Range (m)	Range (m) of Maximum Nos.	Number of Samples	Total Estimated Numbers Collected
A. eschscholtzii	0-1272	0-50	79	13,040
A. tetragona	0-1665	0-100	110	15,608
C. appendiculata	0-2500	0-100	85	7,482
D. bojani	0-996	0-100	86	14,667
D. dispar	0-50	0	35	4,213
E. mitra	0-822	0-250	47	4,250
E. spiralis	0-2500	0-100	31	1,700

TABLE 23

Relative abundance of five groups of organisms collected at stations selected to compare distribution in major Caribbean areas

Region	Station	Siphonophora	Copepoda	Euphausiacea	Chaetognatha	Salpidae	Total
Yucatan Channel	P6701, Sta. 2	215	39,874	569	2,544	20	43,222
	P6805, " 2	800	63,720	790	1,531	0	66,841
	P6811, " 20	230	46,400	40	947	0	47,617
	P6904, " 2	1,550	117,780	70	736	1,250	121,386
Western Caribbean	P6805, " 3	1,100	184,323	330	5,658	100	191,511
	" , " 4	700	74,928	150	838	800	77,416
	P6811, " 14	300	50,866	0	3,521	0	54,687
	" , " 15	120	40,752	100	1,865	350	43,187
	" , " 16	150	61,616	392	1,216	0	63,374
	" , " 17	170	81,372	20	918	0	82,480
	" , " 18	150	107,330	400	1,261	150	109,291
	" , " 19	300	50,188	465	1,266	0	52,219
Central Caribbean	P6606, " 4	400	72,970	1,160	855	300	75,685
	P6805, " 5	250	62,430	498	4,143	50	67,371
	" , " 7	1,550	88,298	360	9,257	55	99,520
	P6811, " 2	60	47,156	550	1,257	30	49,053
	" , " 3	600	124,259	170	1,314	200	126,543
	" , " 4	590	198,608	240	3,872	150	203,460
Eastern Caribbean	P6805, " 9	450	35,339	1,572	2,978	300	40,639
	" , " 10	1,350	25,193	811	2,619	350	30,323
	" , " 11	240	17,108	954	2,636	0	20,938
	P6911, " 1	1,540	77,672	150	586	1,550	81,498
	" , " 2	1,504	63,003	584	2,180	650	67,921
	" , " 3	150	99,664	720	1,926	150	102,610
	" , " 4	210	33,342	400	1,545	620	36,117
	" , " 5	570	52,164	302	1,598	30	54,664
	" , " 6	930	59,293	0	1,292	220	61,735
	" , " 7	124	35,861	600	728	312	37,625
	" , " 8	250	54,345	100	924	2,120	57,739
	" , " 9	1,150	106,718	357	5,293	1,650	115,168

TABLE 23 (Continued)

Region	Station	Siphonophora	Copepoda	Euphausiacea	Chaetognatha	Salpidae	Total
	P6911, Sta. 10	650	97,726	796	3,622	1,850	104,644
	" , " 11	1,210	66,921	112	6,276	550	75,069
Areas of Upwelling	P6606, " 11	0	29,724	0	910	0	30,634
	" , " 12	50	121,957	75	8,600	25	130,707
	" , " 13	50	52,133	270	980	25	53,458
	" , " 14	100	77,500	540	4,000	150	82,290
	P6811, " 5	2,650	112,029	800	7,595	1,000	124,074
	" , " 6	750	85,782	670	1,373	600	89,175
	" , " 7	1,254	94,730	690	3,128	0	99,802
	" , " 8	3,145	25,824	280	1,174	40	30,463
	" , " 9	1,300	129,204	3,350	3,225	105	137,184
	" , " 10	1,450	110,583	1,380	7,847	500	121,760
	" , " 11	625	177,904	2,750	4,617	650	186,546
	" , " 12	670	78,885	84	2,490	200	82,329
Windward Passage	" , " 1	100	90,261	450	2,019	100	92,930
Mona Passage	P6911, " 12	403	74,607	380	2,010	0	77,400
Grenada Passage	G6722, " 15	120	7,966	6	831	64	8,987
	" , " 17	370	33,639	230	1,042	10	35,291

The seven more common species were broadly distributed across the Caribbean and all were collected in the Gulf of Mexico (P 6803, Sta. 4-11). With the exception of *E. mitra*, they also occurred in collections from the Antilles Current (e.g., P 6904, Sta. 15-22). Siphonophores were present at all but one of 48 stations selected to compare abundance of five groups of organisms in the major oceanic areas of the Caribbean (Table 23, Fig. 14). Four of these stations were occupied in the dry season, the two in the Grenada passage and two of the four in the Yucatan Channel. All of the samples used to compare numbers in the western, central and eastern Caribbean and the areas of upwelling were collected during the wet season, presumably the period of greatest productivity.

Absence and very low numbers of siphonophores are a consequence of the phenomenon of swarming as well as patchiness caused by physical and chemical factors. The data summarized in Table 24 suggest that they are most abundant in the eastern Caribbean and the areas influenced by upwelling off Central America between Colombia and Honduras, compared with the central and western Caribbean. The relatively large numbers collected in the Gulf of Darien and the Gulf of Mosquitoes may, however, reflect physical aggregation caused by the general westward drift in combination with the cyclonic circulation in the area, rather than higher productivity associated with upwelling. The abundance recorded for the Yucatan Channel probably did result from the massing of plankton as the Caribbean waters flowed into the strait.

TABLE 24

Data on horizontal distribution of siphonophores summarized from Table 23.

Location	No. of Stations	Range in No. Siphonophores Collected	Avg. of Total No. Collected per Station
Yucatan Channel	4	215-1550	699
Western Caribbean	8	120-1100	374
Central Caribbean	6	60-1550	575
Eastern Caribbean	14	124-1540	738
Areas of upwelling	12	0-3145	1003

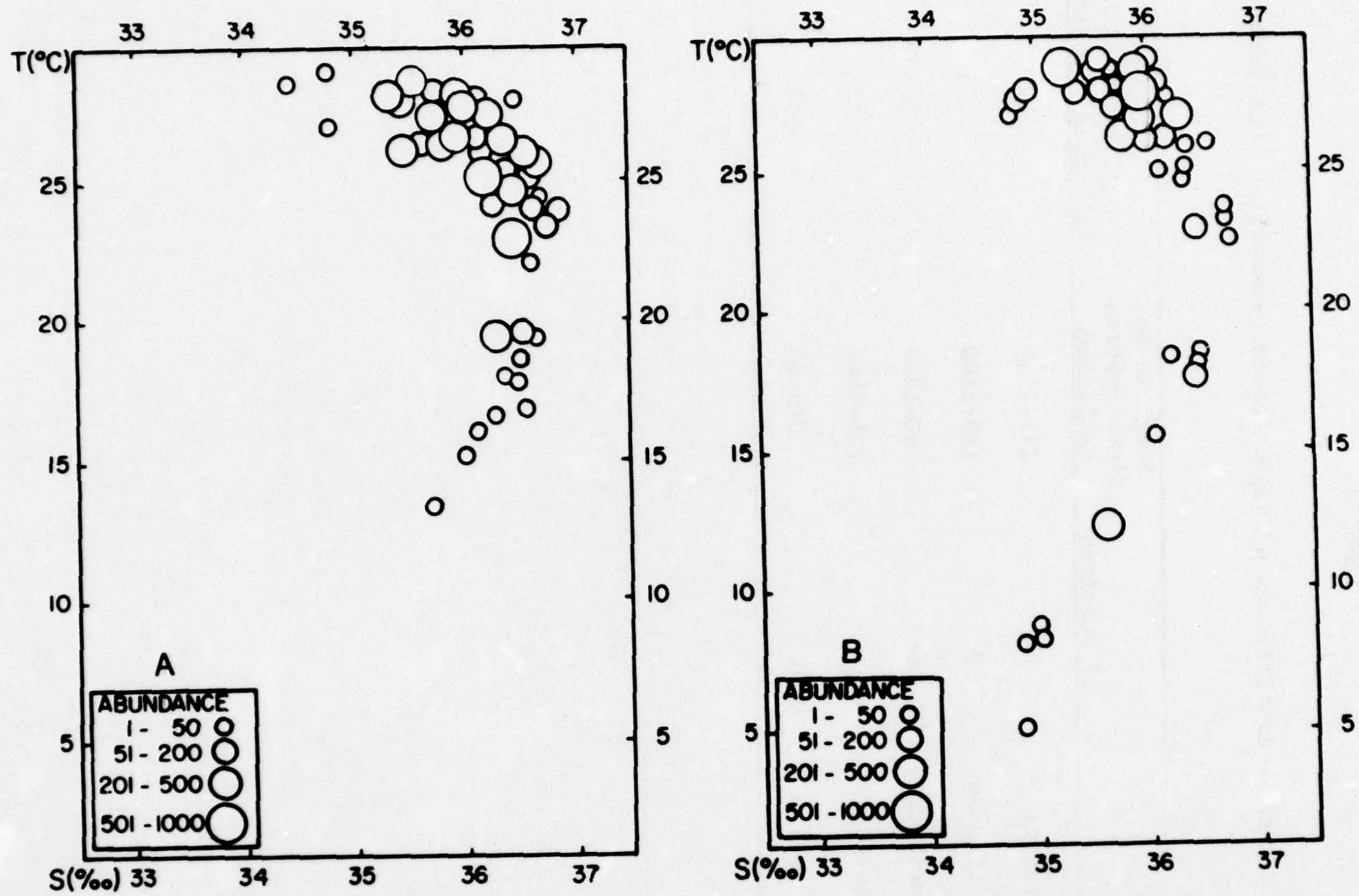

Figure 11. T-S-P diagrams, (A) Abylopsis tetragona and (B) Chelophyes appendiculata

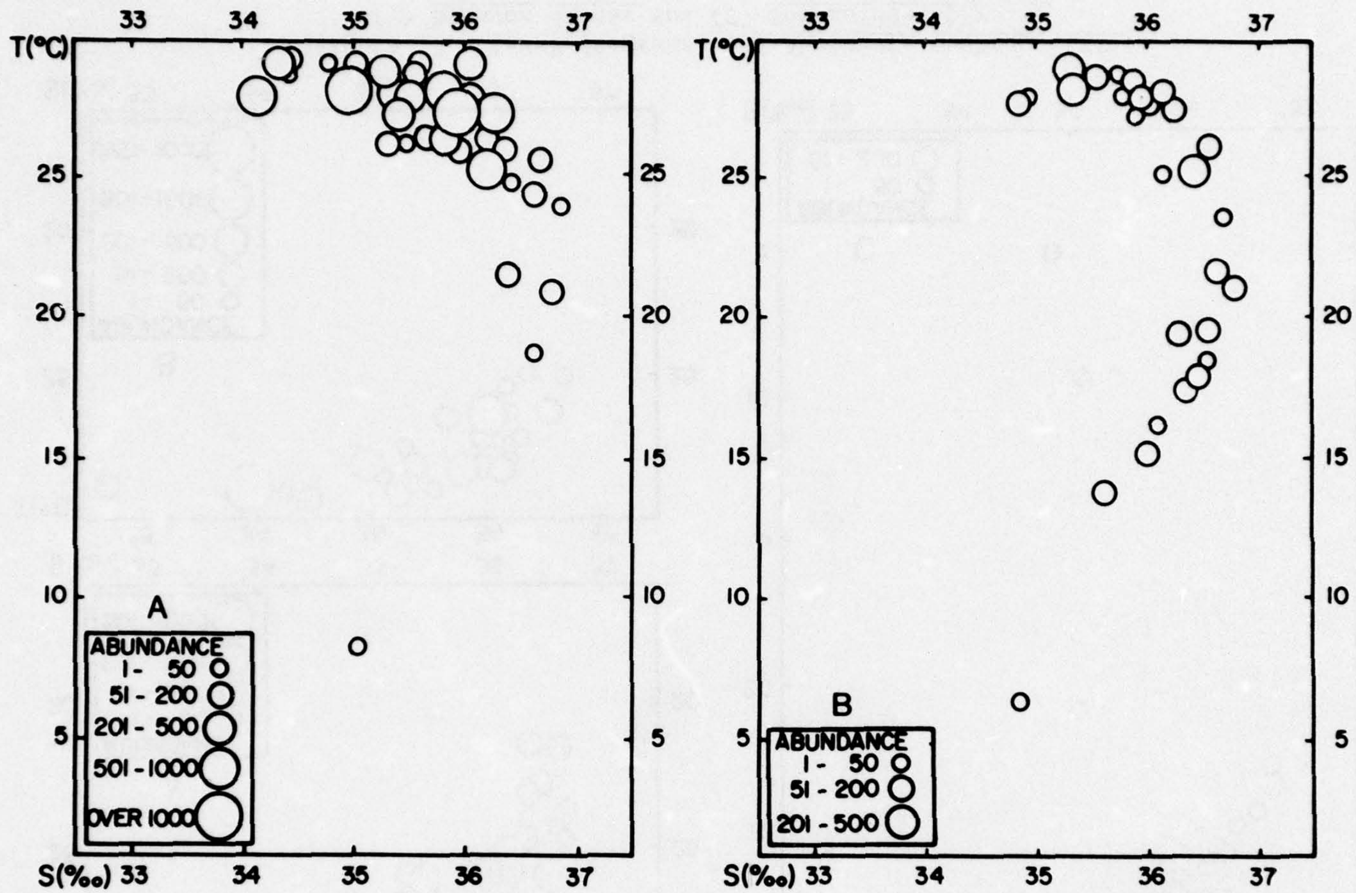

Figure 12. T-S-P diagrams, (A) Diphyes bojani and (B) Eudoxoides mitra

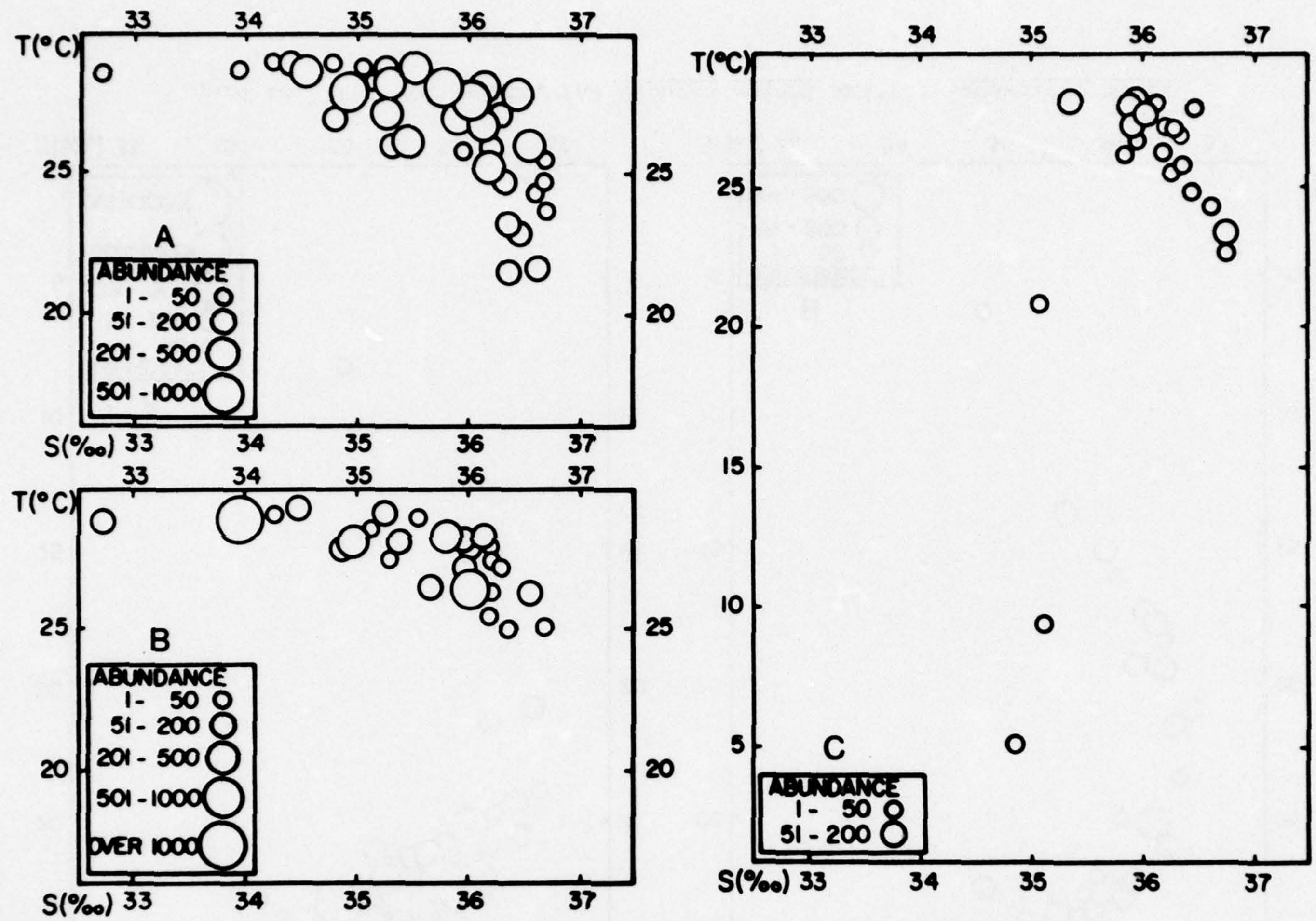

Figure 13. T-S-P diagrams, (A) <u>Abylopsis eschscholtzii</u>, (B) <u>Diphyes dispar</u> and (C) <u>Eudoxoides spiralis</u>

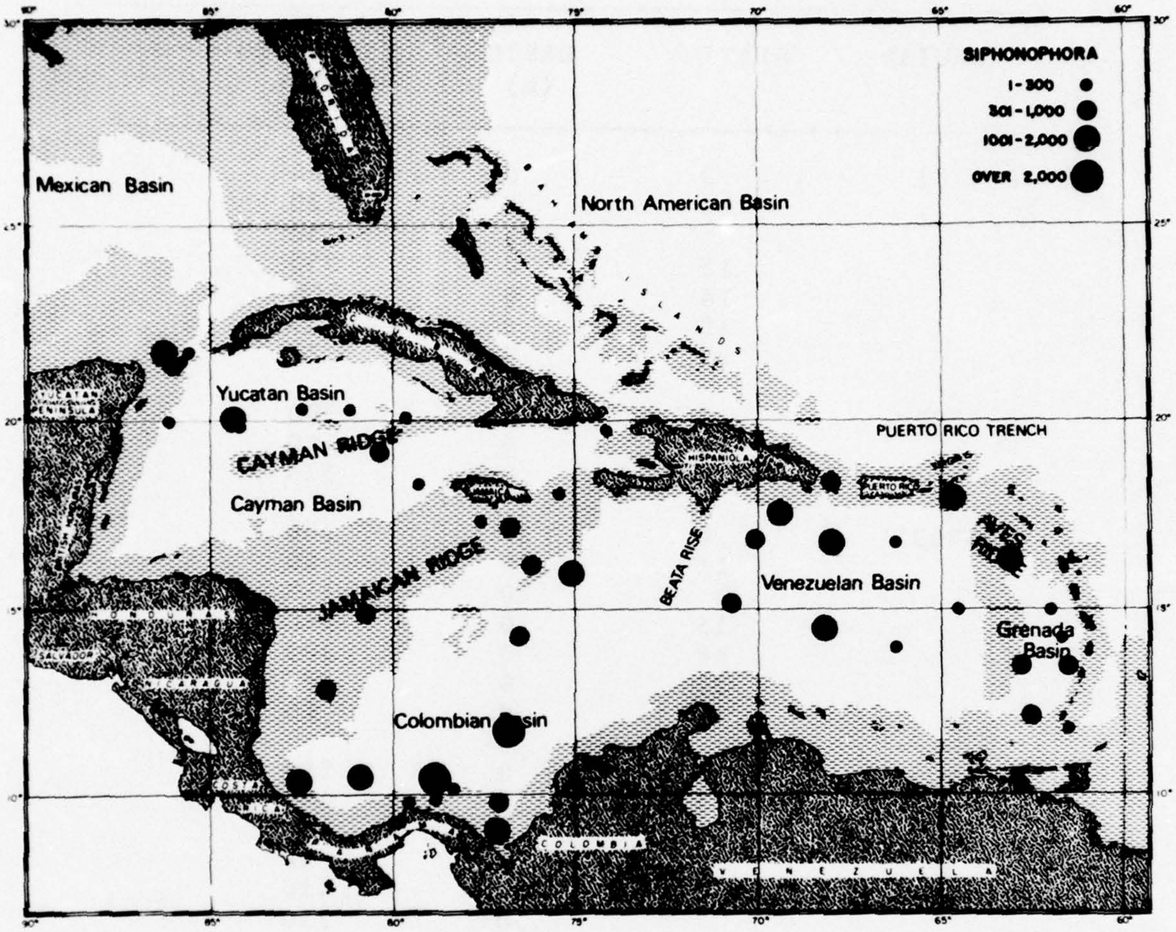

Figure 14. Total numbers of Siphonophora collected at 48 stations selected to compare abundance in major Caribbean areas (see Table 23)

TABLE 25

Vertical Distribution of *Abylopsis eschscholtzii*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6701	3	0	20
	12	0	120
		100	50
	13	0	350
	14	0	100
	18	0	100
	22	0	20
G-6722	9	0	300
	10	0	150
	17	0	320
P-6803	4	30	100
	11	0	80
		30	150
	15	0	160
	18	0	300
	20	0	85
	22	0	10
P-6805	2	0	250
	3	0	450
	4	0	200
	5	0	50
	7	0	450
		50	250
	10	0	100
P-6811	2	0	10
	3	0	300
	5	0	650
	6	0	250
	7	0	30
	8	0	990
		27	30
	9	0	250
		50	150

TABLE 25 (continued)

Vertical Distribution of *Abylopsis eschscholtzii*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
	10	0	150
		25	350
	12	35	100
	14	0	50
	15	0	100
	16	52	50
	18	0	100
	19	0	150
	20	0	150
P-6904	1	0	100
		38	250
	2	0	900
		14	400
	3	0	200
		30	100
	4	0	90
	6	0	250
		31	160
	9	0	10
	10	0	85
		30	180
	11	0	200
		45	350
	12	0	120
	13	0	50
	16	0	58
		59	40
	18	0	40
		62	40
	20	0	140
	21	0	75
P-6911	1	0	120
	2	53	150
		1272	4
	4	0	20

TABLE 25 (continued)

Vertical Distribution of <u>Abylopsis</u> <u>eschscholtzii</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
	5	0	265
	6	0	20
	7	0	20
	9	0	100
	10	56	50
	11	0	100
	12	0	18
	13	0	50
	14	0	30
	16	0	30
		51	200

TABLE 26

Vertical Distribution of *Abylopsis tetragona*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	8	100	100
	12	100	50
P-6701	1	0	10
	2	90	150
		220	5
	3	0	70
		115	25
	4	0	10
	5	0	350
		90	300
	8	0	150
		250	20
	10	0	9
	11	110	150
	12	0	60
		100	450
	13	100	50
	14	100	100
	16	0	60
	20	250	30
G-6722	4	55	200
	9	40	100
	10	45	20
		225	10
	12	0	100
	15	30	20
P-6803	4	0	120
		30	600
	8	40	250
	15	100	50
		200	20
	16	100	80
	17	0	50
		100	50

TABLE 26 (continued)

Vertical Distribution of *Abylopsis tetragona*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
	18	0	120
		100	120
	20	0	55
		75	120
	25	0	20
	26	100	40
P-6805	2	0	50
	3	0	200
	4	90	50
	5	0	100
	7	0	50
		50	350
	9	0	300
	10	0	250
		55	50
P-6811	3	225	180
	4	0	350
		270	20
	5	25	700
	6	25	150
	7	90	4
		125	40
		225	50
	8	27	10
	12	35	100
		160	50
	14	0	50
	17	0	60
		85	50
		237	30
	19	0	100
P-6904	1	38	750
	2	0	250
	3	30	300

TABLE 26 (continued)

Vertical Distribution of Abylopsis tetragona

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
		265	30
	4	30	390
		230	50
		470	25
	6	31	400
	7	25	500
	9	0	15
		70	100
	10	0	19
		30	60
		1665	1
	12	30	500
	13	48	200
	14	37	20
		239	30
	15	52	150
	16	59	120
	18	0	30
		62	60
	19	30	250
	20	0	120
		10	200
	22	0	8
		40	100
		252	30
P-6911	1	65	300
	2	53	350
	3	60	100
	4	81	100
	5	59	60
	6	50	350
	7	0	20
		60	20
	8	60	150
	9	60	400
	10	56	300

TABLE 26 (continued)

Vertical Distribution of Abylopsis tetragona

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
	12	36	10
		200	2
	13	65	500
	15	0	30
		53	320
	17	54	250

TABLE 27

Vertical Distribution of <u>Chelophyes</u> <u>appendiculata</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	13	100	25
	14	10	50
P-6701	1	530	5
	2	0	5
		220	5
	3	0	60
		350	20
	4	0	10
		505	16
	5	0	50
	8	0	200
		505	10
G-6722	10	45	10
		225	45
P-6803	4	30	200
	8	95	50
	11	2500	4
	15	0	40
	16	0	20
		100	20
	17	0	250
		490	20
	20	0	30
	22	0	110
		100	50
	25	0	20
	26	100	40
P-6805	2	0	200
	3	0	450
	4	0	100
	5	0	100
	7	50	50
	9	65	50

TABLE 27 (continued)

Vertical Distribution of Chelophyes appendiculata

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
	10	0	650
P-6811	1	0	50
	2	0	10
	4	0	50
	5	0	50
	6	25	50
	8	0	60
		1000	5
	9	0	100
	10	0	150
	11	0	150
		590	25
	12	35	50
		160	20
	14	0	200
	15	55	20
	17	237	30
	18	0	50
	20	0	30
		75	50
P-6904	1	0	150
	3	30	250
	4	30	90
	6	31	80
	7	25	50
	9	0	65
		676	20
	10	0	6
		30	60
		233	10
		1892	2
	11	0	50
		45	50
	12	30	450
	13	0	300

TABLE 27 (continued)

Vertical Distribution of <u>Chelophyes</u> <u>appendiculata</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
		48	50
	15	52	50
	16	0	4
	17	0	50
	18	0	210
		62	20
	19	0	10
	20	0	30
	21	0	20
P-6911	1	0	570
	9	60	100
	11	58	100
		234	60
	12	344	40
	14	0	60
		34	400
	16	0	60

TABLE 28

Vertical Distribution of *Diphyes bojani*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6701	3	0	60
	4	0	10
	5	0	50
	8	0	150
	10	0	9
	11	110	50
	12	0	10
		100	150
	14	0	200
		100	50
	24	100	100
G-6722	4	0	750
	9	0	500
		40	100
	10	45	10
	12	0	50
		181	10
	15	0	100
	17	250	10
P-6803	11	30	100
	16	0	40
	17	0	250
	20	0	40
		75	40
	22	0	70
	25	0	60
P-6805	2	0	50
	11	0	240
P-6811	2	0	20
	4	50	150
	5	0	750
		25	100
	6	0	50

TABLE 28 (continued)

Vertical Distribution of Diphyes bojani

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
		25	50
	8	0	1740
		27	10
	9	0	400
	10	0	450
	11	0	250
	12	35	300
	19	0	50
P-6904	1	0	900
	3	30	100
	4	30	90
	6	31	40
	7	0	50
	9	676	20
	10	0	1
		30	60
	11	0	50
		45	550
	12	30	1200
	13	0	350
	14	37	60
	16	0	2
		59	80
	17	0	90
	18	0	60
	19	30	50
	20	0	40
		10	50
	21	0	10
	22	40	50
P-6911	1	0	390
	2	0	450
		53	550
	4	0	40
		81	50

TABLE 28 (continued)

Vertical Distribution of *Diphyes bojani*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
	5	59	240
		996	5
	7	0	24
		60	20
	8	60	50
	9	0	150
		60	100
	10	0	200
		56	50
	11	0	50
		58	400
	12	0	6
		36	10
	13	0	100
		65	50
	14	0	180
	15	0	30
		53	40

TABLE 29

Vertical Distribution of Diphyes dispar

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6701	3	0	20
	8	0	200
	22	0	20
G-6722	17	0	40
P-6803	8	0	40
	15	0	80
	20	0	10
	22	0	10
P-6805	2	0	100
	7	50	150
	9	0	100
	10	0	150
P-6811	2	0	10
	5	0	300
	6	0	50
	7	0	1080
	8	0	270
	9	0	150
	10	0	200
		25	50
P-6904	1	0	600
		38	50
	4	30	30
	9	0	10
	11	0	50
	13	0	100
	17	0	50
	18	0	20
	20	0	10
	21	0	10
P-6911	1	0	60

TABLE 29 (continued)

Vertical Distribution of Diphyes dispar

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
	6	0	60
	9	0	100
	12	0	3
	15	0	30

TABLE 30

Vertical Distribution of Eudoxoides mitra

CRUISE	STATION	DEPTH	ESTIMATED
P-6606	14	10	50
P-6701	2	220	20
	3	115	5
	8	505	10
	20	250	90
	24	100	50
G-6722	4	55	50
	10	225	110
	12	80	50
		181	10
P-6803	8	40	100
		175	30
	16	225	1
	22	100	50
P-6805	2	0	100
	4	90	350
	7	50	200
	10	0	150
P-6811	1	0	50
	2	822	10
	3	225	120
	4	270	20
	6	0	50
		25	150
	7	225	50
	8	0	30
	9	0	100
		50	150
	10	0	50
	11	45	200
	12	160	50
	16	52	100

TABLE 30 (continued)

Vertical Distribution of *Eudoxoides mitra*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6904	1	38	50
	5	250	80
	7	25	100
	10	233	30
	11	45	50
	14	239	30
P-6911	1	65	100
	6	50	400
	7	60	20
	9	60	200
	10	56	50
	11	58	500
	12	78	20
		153	60
		200	4

TABLE 31

Vertical Distribution of Eudoxoides spiralis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	13	100	25
P-6701	2	90	30
	4	0	5
P-6803	8	0	20
	11	30	50
		2500	4
	17	0	50
	20	0	35
		75	20
P-6805	2	0	50
	7	0	50
P-6811	5	25	50
	10	25	50
P-6904	4	30	30
	11	0	150
		45	150
	12	30	100
	13	0	150
		48	50
	14	37	40
	15	52	100
	16	0	26
		59	40
	18	0	35
	20	0	40
		10	50
	22	554	20
P-6911	3	60	50
	6	50	100
	8	60	50
	15	53	80

Heteropoda

The three families of the Superfamily Heteropoda were represented in the collections, the Atlantidae by Protatlanta souleyeti, Atlanta peroni, A. inclinata, A. inflata, and A. fusca; the Carinariidae by Cardiapoda placenta; and the Pterotracheidae by Pterotrachea coronata and Firoloida desmaresti. In a review of the group, Thiriot-Quievreux (1973) pointed out that most heteropod species are cosmopolitan in tropical and subtropical waters. Citing distributional records since Tesch's (1949) monograph, she listed no new reports from the western North Atlantic, although the occurrence of Pterotrachea hippocampus and Firoloida desmaresti in the Florida Current was recorded by Owre (1964) and 16 species were collected in the Gulf of Mexico by Taylor and Berner (1970). All except Pterotrachea minuta had been recorded from the Gulf by Tesch (1949).

Thiriot-Quievreux also summarized data on abundance and concluded that the biomass of heteropods within that of the total zooplankton is negligible. On the contrary, Taylor and Berner found that heteropods are "important members of the zooplankton community of the Gulf". Their samples, mostly obtained in oblique hauls, were rich both in numbers of species and in abundance, compared with our collections from horizontal tows. The low numbers found in the Caribbean are doubtless a poor indication of the actual diversity and abundance of these molluscs. Periodic collections from the Florida Current over the past 20 years have shown us that they may be very numerous although patchily distributed, perhaps as a result of swarming. It is also possible that the larger forms in the Carinariidae and the Pterotracheidae, which are strong swimmers equipped with large eyes, can escape plankton nets and that those captured in trawls are often overlooked because their soft bodies are mostly transparent and are easily torn. These suggestions are reinforced by reference to the Atlas of the International Indian Ocean Expedition in which the distribution of the planktonic molluscs collected is

shown (Vol. 3, Fasc. 2, 1971). The widespread but disjunct records and the low numbers of Carinariidae and Pterotracheidae resemble those for cephalopods, which are well known for their ability to avoid plankton nets and trawls.

Stating that the cause of swarming is unknown, Taylor and Berner (1970) rejected Blackburn's (1956) suggestion that swarming in *Firoloida desmaresti* is part of the reproductive process on the grounds that egg strings were present in all of the specimens they collected. Earlier, Tesch (1949) had concluded that "...maturity is evidently not strictly dependent upon a certain size...", after finding females of 10-40 mm in length with egg-strings. Then Owre (1964) showed that the nidamentary filament of *F. desmaresti* is present even in the minute juvenile (1.2 mm), newly metamorphosed from larval to adult form. Probably both swarming and funneling of surface waters through the Yucatan Channel accounted for the large numbers of specimens, 10-20 mm long, collected on P 6904 (Table 32). The need for fertilization of the sexually mature female of this and other species remains a reasonable explanation for swarming which must be a normal phenomenon in the lives of successful, bisexual, holoplanktonic forms, perhaps even from their earliest free hours. Otherwise their reproduction would be an unlikely event in the open sea.

Few data on the vertical distribution of heteropods exist, as Thiriot-Quievreux (1973) noted. Usually they have been collected in surface waters but records from 1000 and 5000 m exist. At one station in the Gulf of Mexico, Taylor and Berner (1970) used Bongo nets to fish at 50, 100, 200 and 400 m. Most specimens were caught in the upper 100 m, a few at 200 m and two individuals at 400 m. Table 32 contains our records all either from surface samples or from the depth of the thermocline.

No species was abundant in the Caribbean collections. *Atlanta peroni* and *Firoloida desmaresti* were those most frequently caught, and the latter and

A. inclinata were the most numerous, particularly in two stations in the Yucatan Channel (P 6805 and P 6904, Stations 2; Table 32). In contrast, A. peroni was relatively rare in the Gulf and was replaced as the second most abundant form by A. lesueuri (Taylor and Berner, 1970). Dales (1952) found F. desmaresti very rare and P. hippocampus common off the Pacific coast of North America. Much remains to be learned about the relationships and ecological requirements of these highly modified, predaceous molluscs in the epipelagic communities of tropical oceans.

TABLE 32

Distributional Records of Heteropoda

Species	Cruise,	Station	Depth (m)	Total Numbers (whole counts)
Protatlanta souleyeti	P 6811,	18	114	1
	P 6911,	8	60	1
Atlanta peroni	G 6722,	10	45	1
	P 6805,	2	0	2
	P 6811,	17	85	1
		20	0	3
	P 6904,	4	0	2
		15	52	2
		16	0	2
	P 6911,	1	0	1
A. inclinata	P 6805,	2	0	8
		7	50	12
A. inflata	P 6811,	9	0	2
A. fusca	P 6904,	11	0	1
Cardiapoda placenta	P 6811,	20	75	1
Pterotrachea coronata	P 6811,	7	125	1
Firoloida desmaresti	P 6606,	8	100	1
		12	100	1
	P 6701,	3	0	2
	P 6805,	3	100	1
		4	90	1
		7	50	2
	P 6904,	1	38	2
		2	0	33
			14	1
		16	0	1
		18	0	1

Copepoda

Introduction

The biology of copepods has interested many ecologists and systematists, receiving more extensive study than that of other groups of zooplanktonic organisms, because of the great diversity and enormous abundance of these forms, especially in the euphotic zone, and their primary position in energy transfer in the oceans. This is true in the Caribbean and adjacent areas as well as the better known temperate regions. However, few data on biomass in the oceanic and even in coastal waters have been published, while there are numerous reports on taxonomy and distribution in limited areas, from northern Venezuela to the Mississippi delta, with special emphasis in recent years on Cuban waters, the Florida Straits, and the Campeche Banks of the southeastern Gulf of Mexico.

Those reports published in the first half of the 20th century, consisting mainly of analyses of a few samples collected by the CARNEGIE (Wilson, 1942) and the ALBATROSS (Wilson, 1950), were reviewed by Björnberg (1971), Owre & Foyo (1964, 1971) and others. Subsequently, Fleminger (1956, 1957a, b, c) pioneered broad systematic studies of calanoids in the Gulf of Mexico, closely follwed by Grice (1956, 1960a,b), who reported on both calanoid and cyclopoid species and also examined collections from the Florida Keys. E. C. Jones (1952) made the first extensive investigation of calanoids, harpacticoids and cyclopoids in the Florida Current off Miami. The occurrence of species in these three groups of copepods in Caribbean waters off Venezuela was reported by Cervigón (1963, 1964) and Legaré (1964), and, at a more northerly position in the eastern Caribbean, by Owre & Foyo (1964). Meanwhile Owre (1962) and Owre & Foyo (1967) had continued Jones' studies of Florida Current

material, summarizing past work in the Caribbean and *Florida Current* in their account of 216 species collected in those areas. As a result of the 1964-1965 Soviet and Cuban Joint Marine Expedition, lists of species found in the western Caribbean, the Florida Straits and the Gulf of Mexico began to appear in Russian publications in 1966 (Kolesnikov & Alfonso, 1966; Moryakova & Kampos, 1966) and were later expanded (Kolesnikov, 1968; Moryakova, 1968). These lists include 52 previously unreported species of calanoids, harpacticoids and cyclopoids, several of which were subsequently cited by other authors as new records for the area. Grice (1969) and Park (1970), who analyzed collections from the western Caribbean and the Gulf of Mexico, published a total of 107 new records and descriptions of new species. Owre & Foyo (1972) added two calanoid species to the list of records, and Park (1974, 1975a, b, c, d), 19 new calanoid species and records. Although some of the reports, particularly of Cyclopoida ought to be corroborated, the tally for these oceanic areas definitely approaches 450 species, and there are undoubtedly more to be found, particularly in samples from 500 m and below. We have separated specimens which, even under casual inspection, appeared new, as has, in the case of certain genera, Dr. G. B. Deevey, who examined some of the samples and has also described new species of ostracods from them (Deevey, 1975).

A complete taxonomic analysis of the copepods in the collections was thus considered outside the purpose and scope of the project, in view of the large numbers of species involved, the taxonomic studies cited earlier and the continuing investigations by Taisoo Park, of Texas A&M University, and G. B. Deevey of the University of Florida. Instead, 20 common, frequently caught, readily identified species, with broad vertical ranges were selected as representatives of Caribbean copepods. The process of selection, although arbitrary, was enlightened by past experience in making complete analyses of copepods

in Caribbean plankton samples (Owre & Foyo, 1964, 1972). Eleven species of calanoids, three of harpacticoids and six of cyclopoids were counted in all samples, usually by aliquot. In relatively small samples, all specimens were counted. Their abundance and distribution are shown in Figs. 15-24 and Tables 35-45, 47-49 and 51-56. In addition, the total numbers of other calanoid, harpacticoid and cyclopoid species in each sample were determined by a complete count or estimated by counting them in aliquots, and these are reported as "Total Other Calanoida", etc. in Tables 46, 50 and 57. Adding these counts for any sample or any station gives total copepods collected per one hour of horizontal towing. Total numbers collected at 48 selected Caribbean stations are illustrated in Fig. 25 and can be compared with similar charts showing the horizontal distribution of abundance of other planktonic groups (Figs. 14, 35, 43, and 46). Because of the numerical importance of copepods in the zooplankton, estimated total numbers collected at all stations are shown in Fig. 26.

The lists in Table 33, of total vertical ranges and total estimated numbers collected of each species and group show the remarkable extent of their vertical distribution as well as their abundance relative to one another. Some species were found to be numerous throughout the great depth range (_Rhincalanus cornutus_ forma _atlantica_, Fig. 19A) while others were clearly concentrated in the upper (_Farranula carinata_, Fig. 22B) or lower (_Conaea gracilis_, Fig. 22A) portions of it. The problem of contamination in deep samples will be discussed at the end of this section.

Relative numbers of species and the three groups, expressed as percentages in Table 33, show several basic facts about oceanic copepod populations in the tropical and subtropical areas studied. There are very few references to consult concerning the occurrence of the three groups and none with comparable numbers of specimens. Data on numbers of species in these reports are

TABLE 33

Relative abundance and vertical range of copepods collected in the Caribbean Sea and adjacent areas.

Species or Group	Total Range (m)	No. of Samples	Total Numbers	%
Acrocalanus longicornis	0-2454	105	28,856	0.78
Clausocalanus furcatus	0-3594	233	189,191	5.11
Euchaeta marina	0-2660	147	82,029	2.21
Haloptilus longicornis	0-3560	244	50,990	1.37
Lucicutia flavicornis	0-4350	239	54,219	1.46
Mormonilla minor	27-5200	508	159,076	4.30
M. phasma	100-3560	329	14,270	0.38
Paracalanus aculeatus	0-4350	144	70,543	1.90
Rhincalanus cornutus forma atlantica	0-3602	394	53,206	1.43
Scolecithrix danae	0-2500	87	22,414	0.60
Undinula vulgaris	0-1000	83	66,514	1.79
Other Calanoida	0-7500	794	2,905,723	78.59
Total Calanoida			3,697,036	99.93
Aegisthus aculeatus	0-4350	173	1,694	0.43
Macrosetella gracilis	0-6220	343	80,563	20.83
Microsetella rosea	0-7500	532	270,068	69.83
Other Harpacticoida	0-6220	329	34,422	8.90
Total Harpacticoida			386,747	99.99
Conaea gracilis	0-5200	420	45,690	1.34
Farranula carinata	0-5200	243	412,740	12.14
F. gracilis	0-2500	62	12,895	0.37
Oithona plumifera	0-5200	601	491,616	14.46
Oncaea mediterranea	0-3144	301	56,584	1.66
O. venusta	0-5200	329	124,782	3.67
Other Cyclopoida	0-7500	783	2,254,849	66.33
Total Cyclopoida			3,399,156	99.97

summarized here:

	Legaré (1961) no. spp.	%	Kolesnikov (1968) no. spp.	%	Moryakova (1968) no. spp.	%	Owre & Foyo (1967) no. spp.	%
Calanoida	59	60	91	63	101	66	168	78
Harpacticoida	5	5	9	6	9	6	9	4
Cyclopoida	35	35	44	31	44	28	39	18
TOTALS	99	100	144	100	154	100	216	100

The reports by Legaré, Kolesnikov and Moryakova all include data from stations in coastal areas while that of Owre & Foyo *does not*. Inspection indicates that the number of calanoid and harpacticoid species increases with distance from land while that of cyclopoids decreases. The abundance of organisms does not, however, mirror the percentage relationships of the three groups in any of the regions examined.

The Harpacticoida, which consists mainly of benthic species, is the smallest group of planktonic copepods, comprising 4-6% of the total in the previous reports and 5.2% of the numbers caught in the present study (Table 33). However, one of these minute forms, Microsetella rosea, was collected in impressive abundance. Although known to occur in the area (Legaré, 1964; Owre & Foyo, 1967) yet not reported in the two Caribbean studies by Owre & Foyo (1964, 1972), or from Barbados by Lewis & Fish (1969), M. rosea emerged as the third most numerous copepod species counted, far outranking the calanoids, most of the cyclopoids and the other two species of harpacticoids, as well as all other harpacticoid species combined.

With regard to Calanoida and Cyclopoida, the total numbers of species present in the area have yet to be established, as pointed out earlier, but it is certain that calanoids far outnumber cyclopoids. In abundance of individuals, however, cyclopoids nearly equalled calanoids in our collections,

accounting for 45.4% of total copepods compared with 49.4%. Oithona plumifera and Farranula carinata were the most numerous of the 20 copepod species counted, and they, with M. rosea, exceeded even the most common calanoid species. Also, the counts of "Other Cyclopoida" represented over 66% of the total number of cyclopoids. It seems that the importance of this group has been overlooked in past biological studies, perhaps because many species are small and identifying them is a tedious process. In the tropics, at least, cyclopoids and harpacticoids certainly should not be excluded from studies of biomass and biology. Among the calanoids, Clausocalanus furcatus, Euchaeta marina and Paracalanus aculeatus are the most numerous primarily epipelagic species, and Mormonilla minor appears to be important in meso-bathypelagic realms.

No attempt was made during the Caribbean survey to determine non-migration or diurnal migration of copepod species. Samples were collected shortly after arrival at each station, regardless of time of day or night. However, the tables listing vertical distribution of numbers of the various species and groups obviously contain much information on occurrence in relation to time of day, and this will be treated briefly in the accounts of species. Those readers interested in diurnal migration will want to convert GMT, used in recording all data in Tables 13-20 to local apparent time. Although the latitudinal spread of the stations extends from 59°33'W, where the time is 3 h, 58 min earlier than GMT, to 88°29'W, where the difference is 5 h, 54 min, a quick approximation can be made by subtracting five hours from the GMT, which gives the time along the 75°W meridian.

In the only recent publications dealing specifically and in detail with copepods, Roe (1972a, b, c, d) reported data from an investigation off Fuerteventura, Canary Islands, of the vertical distribution and diurnal migration of 212 species of calanoids, collected and analyzed by modern methods. One

valuable aspect of Roe's 1972a paper is his summary of previous work and his discussion of the difficulties of comparing results with those previously published data. He pointed out the importance of mesh size of net, the effect of different sampling methods, the major influences on distribution of organisms exerted by geographic position, water masses, and, most important, time with its daily impact on the vertical distribution of many species and its influence on reproduction. Roe was working with one day and one night series of horizontal hauls collected at 19 depths from 40 to 960 m. Roe's data from a temperate area are important in our interpretation of the distribution of species common to both collections: Euchaeta marina, Haloptilus longicornis, Lucicutia flavicornis, Rhincalanus cornutus, and Scolecithrix danae. Our results concerning all three groups compared with his information on calanoids alone verify his statement that, "...in most of the Atlantic Ocean the maximum numbers of calanoid copepods are in the upper 100 m by both day and night and there are often secondary mid-water maxima by both day and night."

Inspection of the tables giving vertical distribution of the more numerous groups, e.g., Tables 46 (other Calanoida), 54 (Oithona plumifera) and 57 (other Cyclopoida), without regard for time, affirms that copepod populations are concentrated in the upper 250-350 m throughout the area. Occasionally, large numbers occurred around 500 m. The majority of specimens usually was caught in the two or three shallower tows, i.e., in the upper 100 m. At the 103 stations where "other Calanoida" were counted, for example, at least 75% of the total catch was found in the upper 100 m at 67% of the stations, and more than 50% occurred in this depth range at 83% of the stations. Below 500 m, the numbers are essentially negligible, even considering deep-living species such as Mormonilla minor. This confirms our earlier conclusion, based on only 18 samples from stations in the eastern Caribbean, that relatively few species

which are very numerous in individuals are concentrated in the upper 100 m, while the greatest species diversity and least abundance are found below 500 m (Owre & Foyo, 1964).

The numerical vertical distribution of some species calls attention to the effects of upwelling, although none is as useful for this purpose as certain chaetognath species. Epipelagic copepods whose numbers are concentrated over a relatively short range show the effect by their absence or by greatly diminished numbers, whereas the deeper-living forms tend to be spread over a far greater range and a shift upwards or downwards may not be particularly noticeable. On the other hand, meso- and bathypelagic chaetognaths characterized by greater stratification, are obviously out-of-place in shallow water. In the case of the vastly numerous epipelagic copepods, the possibilities of horizontal and vertical recruitment coincident with the effects of the upwelling further lessen their reliability as indicators. However, some fairly clearcut anomalies in distribution can be cited. Using the areas at P 6701, Sta. 20-22, where Tropical Surface Water was displaced (Table 11), and P 6811, Sta. 9, where deep water was uplifted, for examples, one finds that *Acrocalanus longicornis*, an epipelagic species most abundant in surface collections, was absent altogether. *Clausocalanus furcatus*, the most numerous calanoid species counted, which is usually concentrated slightly deeper than *A. longicornis* but still in the upper 100 m, was also missing in these locations except for a few specimens caught below 800 m. At the P 6701 stations, *Paracalanus aculeatus*, *Scolecithrix danae* and *Undinula vulgaris* were either present in very low numbers or absent at depths where ordinarily they were numerous. *P. aculeatus* was not collected at P 6811, Sta. 9, while *S. danae* and *U. vulgaris* were fairly numerous at 50 m and the surface, respectively, perhaps as a result of recruitment from greater depths. Possibly a detailed study of vertical distribution and relative abundance of copepod species in upwelling areas off Colombia and Venezuela and in

the Central American cyclonic gyre, such as Roe (1972a, b, c, d) made off the Canary Islands, would show the features of the copepod populations which characterize types and degrees of upwelling in these tropical regions. However, one wonders if this would be of any but academic value since many chaetognath and thecosome species (see Part II) are known to be reliable indicators of water masses.

The catches of epi- and mesopelagic species from unusually great depths are considered by many specialists to be the results of contamination as the net is lowered to fishing depth. A study of the problem was made by Grice & Hulsemann (1965), who analyzed samples from the northeast Atlantic between 30° and 60°N, which had been collected in vertical tows of a net made of material with an aperture size of 0.23 mm. They concluded that a number of species are contaminants below certain depths, among them *Clausocalanus furcatus* and *Paracalanus aculeatus*, below 100 m, and *Lucicutia flavicornis*, below 1000 m. As these are among the species individually counted in our study, all of which had great vertical ranges, the data on distribution below these depths require evaluation. Some contamination is almost impossible to avoid if plankton is collected by net. To reduce the likelihood of contamination, we rolled each net tightly and secured it for the descent to fishing depth. On the return trip, the net was collapsed and unlikely to receive further material in the catch bottle. The same nets were routinely used to fish at particular depths. No matter how carefully a net is washed, some organisms will cling to it and will be carried into the catch bottle during the next tow. However, the desiccated appearance of these animals shows that they were not collected alive in that sample. We eliminated such individuals from our counts. Because of the care taken to avoid contamination and the frequency with which the three species appeared in our deeper samples, other explanations for their presence should be explored, although a thorough evaluation is beyond our

scope at present. Only 0.8% of the specimens of C. furcatus were caught below 100 m, but these appeared in 84 samples from 48 stations. On the other hand, 5% of the catch of P. aculeatus was collected below 100 m, in 36 samples from 20 stations. L. flavicornis occurred below 1000 m in 37 samples from 28 stations, the numbers amounting to 0.12% of the total. Two or all three of the species were found in deep samples at several stations situated either near the Antillean passes, in the path of the Caribbean Current or the Antillean Current or in areas where upwelling occurs. These stations are: Antillean passes, G 6722, Sta. 4, 9, 17, P 6911, Sta. 3, 5, 6; central Caribbean areas (Caribbean Current), P 6701, Sta. 10-14, 18, P 6803, Sta. 22, P 6811, Sta. 3, P 6904, Sta. 6, 10; upwelling areas, P 6701, Sta. 20, 22, 24, P 6811, Sta. 10; Antillean Current, P 6904, Sta. 15, 18, 19, 20. Probably there are several mechanisms which, with contamination, account for the frequent occurrence of these species well below the level of maximum numbers, among them sinking of shallow water and mixing in turbulent areas, both of which could result in entrainment of epipelagic forms in deep water.

Distribution

Acrocalanus longicornis, according to present Caribbean records, has a vertical range of 0-2454 m but it is abundant only in surface waters (Tables 33 and 35). The number of specimens collected below the surface amounted to only 24% of the total catch and most of these came from the upper 50-60 m. Thus A. longicornis lives primarily in Tropical Surface Water over the broadest range of temperature and salinity recorded in our data, and it also was frequently caught in Subtropical Underwater (Fig. 15A). Roe (1974a) did not find it in the Canary Island collections. Binet & Dessier (1971) reported it usually rare, although common in one surface catch, in the Gulf of Guinea off the Congo. There is no evidence that this species undergoes diurnal migration; the largest catches were collected in surface waters in mid-afternoon (G 6722, Sta. 9; P 6811, Sta. 3).

Males of Acrocalanus longicornis are very rare, none having been found in all of the Caribbean and other samples. Owre & Foyo (1964, 1967) also reported only females from the Caribbean and the Florida Straits but later (1972) collected a few males at 50 m in the Windward Passage.

Clausocalanus furcatus, the most numerous calanoid species individually studied (Table 33), had a greater vertical range than A. longicornis and, although also an epipelagic species, was less common in surface catches. It was mainly confined to the upper 100 m, less than 1% of the total count having been caught below this depth. Owre & Foyo (1964) reported collecting 97% from the upper 100 m. Thus, C. furcatus was very abundant in SUW as well as TSW, and it occurred in small numbers in NACW, SAIW and NADW (Fig. 15B). Roe (1972a, 1974) lumped the species of Clausocalanus and termed them non-migrants.

Our data confirm that its abundance in shallow water does not appear to be related to time, contrary to the conclusion drawn by Owre & Foyo (1967) on the basis of fewer data. Males were very rare in this as well as previous collections (Owre & Foyo, 1964, 1972).

The distribution of Euchaeta marina in the Atlantic, recorded by many authors, has been reviewed by Owre & Foyo (1967) and Roe (1972c), who found it "...surprisingly, not very common." It was the third most numerous calanoid species counted and had a relatively restricted vertical range compared with the others (Tables 33 and 37). Past reports from the Caribbean and the Florida Straits have shown it to be found primarily in the upper 100 m; in the present collections, only 3% was caught below 110 m. It thus occurred mainly in TSW, although not in the lowest salinities, and it was also abundant in SUW. its distribution extended in small numbers through NACW and SAIW (Fig. 16A).

Roe's (1972c) data suggested to him that E. marina performs a reversed migration, although others have reported that it moves upward at night. No evidence of a strong migration in either direction is found in our data since 43% of the total number of specimens was caught at the surface, with only a slight majority of 23% at night. Considering the upper 60 m, where 79% of the total catch was collected, there was, on the other hand, a slight majority of 41% in the daytime. The largest catch of all, consisting of males, females and copepodites, was found in a surface net tow during the daytime (P 6701, Sta. 8). This certainly appears to have been part of a swarm. No doubt sexual reproduction in all of these forms depends upon swarming. The samples were too widely spaced to provide information on migration in a basically epipelagic species, but they do show that it does not avoid the surface in the daytime.

Haloptilus longicornis has been extensively studied in the North Atlantic

as shown by the summaries of Owre & Foyo (1967) and Roe (1972d), who investigated its vertical distribution off Fuerteventura. Most records indicate that maximum numbers are to be found between 50 and 250 m, although it has a great range in the Caribbean (Table 33), equalled only by Wheeler's (1970) Atlantic record of 4100-2200 m. The Caribbean data show that the species is concentrated between approximately 100 and 250 m day and night, living in lower TSW but most abundant in SUW and upper NACW (Table 38, Fig. 16 B). The deeper records are from SAIW and NADW. Authors have reported finding no migration (Farran, 1926; Roe, 1974), reversed migration (Moore, 1949; Roehr & Moore, 1965), and distinct upward migration at night (Roe, 1972d). Our data do not show a regular vertical movement of any kind in the Caribbean. Most of the animals were caught in the upper 110 m during the day (22%) and night (16%) and between 232 and 285 m during the day (22%) and night (15%).

The distribution of <u>Lucicutia flavicornis</u> in the North Atlantic has been reviewed by Owre & Foyo (1967) and Roe (1972d). Its total vertical range in the Caribbean of 0-4350 m exceeds that of Wheeler (1970) for this species in the Atlantic (4100-2200 m). The literature contains conflicting information on its behavior and distribution. In the Caribbean, it was similar to <u>Haloptilus longicornis</u>, though its abundance was greatest in TSW (Table 39, Fig. 17A). Roehr & Moore (1965) reported an upward migration at night, and Owre & Foyo (1967) also found evidence of diurnal migration in the Florida Straits because most individuals were caught below 100 m in the daytime and well above this depth at night. Roe (1972d), however, reported <u>L. flavicornis</u> abundant in the "surface" hauls, meaning those in the upper 50 m, with the maximum numbers at 40 m in the daytime and at 50 m at night. In another study, Roe (1974) determined that it was among those species which are abundant at approximately

250 m by day and which leave this layer at night. In our collections, only 6% of the specimens were caught in the surface net, all at night except for one specimen (P 6911, Sta. 8). About 70% were collected in the upper 115 m, 44% of these at night. Approximately 19% occurred below 115 m in the daytime and 11% at night. These figures suggest that the animals swim upward at night. Definitely *L. flavicornis* avoids surface waters in the daytime, unlike *Acrocalanus longicornis* and *Euchaeta marina*.

Mormonilla minor, a species reported only twice from the western North Atlantic (Grice, 1963; Owre & Foyo, 1972) and twice from the Caribbean (Owre & Foyo, 1964, 1972), to the best of our knowledge, is shown by our data not only to be among the most numerous of copepod species but also one of the few living in abundance below the Subtropical Underwater (Tables 33 and 40, Fig. 17A). Like all of the species individually studied, *M. minor* had a broad vertical range, extending from TSW, into which it probably was carried as a result of upwelling, to NADW, but it is primarily a species of NACW and SAIW. The maximum numbers were routinely caught either in the net fished at approximately 250 m or the one at approximately 500 m (e.g., P 6805, Sta. 10 and 11).

The fact that *M. minor* is so common as well as widespread in its distribution within the broad areas sampled makes its absence from the extended lists of calanoids reported by Kolesnikov (1968) and Moryakova (1968), who included other species of *Mormonilla*, and Park (1969) very puzzling. The samples examined by the former two were collected with a Juday ("Jeddy" in the English translation) net, and Park's were obtained with a modified Nansen vertical net of mesh with an aperture of 0.239 mm, which certainly ought to retain copepods over 0.5 mm long. Although it was not reported from the Florida Straits by Owre & Foyo (1967) or previous workers, we found it common at stations north of Cuba (e.g., P 6701, Sta. 1; P 6803, Sta. 25, 26). In the Gulf

of Mexico, it did not occur at the two eastern stations, no doubt because the water masses in which it normally lives were not present at those shallow locations (P 6803, Sta. 4, 5, bottom soundings 150 and 73 m, respectively). On the other hand, at Sta. 8, off the Mississippi delta, where the sounding was 237 m, upwelling apparently brought populations to unusually shallow levels (Tables 16 and 40). The effects of upwelling in the Central American cyclonic gyre can be seen in the data from P 6811, Sta. 8, where the shallowest occurrence of M. minor (27 m) was discovered. Another shallow record in TSW was found at P 6803, Sta. 20, over the northern Jamaica Ridge. This could have been a result of mixing as currents passed from the much deeper areas of the Venezuelan and Colombian Basins to move up and over the Jamaican Ridge.

The presence of a few males of this species is noted in Table 40. They may be the first to be found, and they will be described in a separate publication. In the case of M. phasma, discussed next, the male apparently remains unknown.

Mormonilla phasma, although hardly well-known, is less of a mystery in its distribution than M. minor since it has been reported from the western North Atlantic, the Florida Straits and the Caribbean Sea by Grice (1963), Kolesnikov (1968), Moryakova (1968) and Owre & Foyo (1964, 1967, 1972). Kolesnikov seems to have been the first to record it from the southwestern Gulf of Mexico. In our material from the Gulf, it was limited to P 6803, Sta. 11, where the bottom depth was 3152 m and it was collected at four levels from 580 to 2000 m. M. phasma was far less numerous than M. minor and more restricted in both horizontal and vertical distribution. The only species of those counted which was never collected in TSW, it occurred from SUW to NADW, but maximum numbers were found in NACW and SAIW, roughly between 500 and 1000 m (Fig. 18A). The biggest catches were regularly found in nets towed in the vicinity of 500,

750 and 1000 m (Table 41). The shallowest record, 100 m, where one specimen was collected, was located at a position affected by upwelling, off Venezuela (P6701, Sta. 20).

The present information is contrary to the few data resulting from the first cruise (P6602, Owre & Foyo, 1972). Both species of Mormonilla were found in samples collected in the Caribbean and also in the North Atlantic off northeastern South America. M. phasma was the more numerous and more frequently caught of the two. Grice (1963) also caught it more frequently than M. minor. Perhaps this shows how faulty conclusions can be drawn from small, spotty samplings across great sea distances. In the case of our series the difference may also be related to the difference in nets, those used on P 6602 having been 0.5 m in diameter at the mouth, made throughout of 200 micron Nitex, and judged poor for general collection of net plankton (Owre & Low, 1969; Owre & Foyo, 1972).

The distribution of Paracalanus aculeatus in the western North Atlantic and the Caribbean was reviewed by Owre & Foyo (1967). These authors also reported finding it in tows from 0-34 m at one eastern Caribbean station and at five off northeastern South America (1972). Davis (1950), Grice (1960) and Park (1969) recorded it from the Gulf of Mexico, but apparently there are no previous reports from the Florida Straits. It was found twice in the Florida Current north of Cuba (P6701, Sta. 1 and P 6904, Sta. 1), which makes its absence in the several copepod studies in the Straits puzzling.

P. aculeatus lives primarily in TSW and SUW. It tolerated the lowest salinity recorded but the temperature range of the maximum numbers is limited (Fig. 18B). As discussed in the introduction to this section, Grice & Hulsemann (1965) consider it a contaminant below 100 m in the northeast Atlantic (30-60°N). It is a creature of the upper 100 m in the tropics as well (Table 42).

Probably it does not migrate diurnally except on a small scale, perhaps in relation to developmental stage or season or both. Expressed as percentages of the total catch, slightly smaller numbers were collected in the upper 100 m (42%) and in the surface net (30%) in the daytime compared with night (50% in the upper 100 m and 35% caught at the surface).

Rhincalanus cornutus forma atlantica, the most frequently caught calanoid next to Mormonilla minor, occurred in considerable abundance over a vertical range of 0-3602 m (Table 33). Its distributional records in the North Atlantic, the Caribbean and the Gulf of Mexico were reviewed by Owre & Foyo (1967) and Roe (1972b), who agreed with others that it is primarily a midwater form which also occurs at the surface. Our data confirm this general statement (Table 43, Fig. 19A), but it was definitely rare at the surface (2% of the total number), where it was caught five times at night and twice in the daytime (P 6805, Sta. 7 and P 6904, Sta. 15). One night catch was made at a very shallow location in the eastern Gulf of Mexico (P 6803, Sta. 4). It was a common form in TSW and SUW, but the majority of the animals were living in NACW and SAIW. Moore & O'Berry (1957) concluded from their studies of R. cornutus in the Florida Straits that it has a very extensive diurnal migration, but Roe (1972b) found only "...some evidence for a slight vertical migration." Our data offer no consistent proof of a large scale regular migration.

Scolecithrix danae has often been reported from the North Atlantic, the Caribbean and the Gulf of Mexico (Owre & Foyo, 1967; Roe, 1972c). Although Wheeler (1970) recorded it from 4100-2200 m and it was collected as deep as 2500 m during our program, S. danae has consistently been found to be most abundant in the upper 100 m. In Roe's study, maximum numbers occurred at 40 m in the daytime and at 50 m at night. We counted less than 2% of the total numbers in samples collected below 115 m. On the other hand, those in surface

samples comprised only 6% of the total, all except the specimens from P 6911, Sta. 11 caught at night or twilight (Table 44). Thus it is an inhabitant of TSW and SUW, primarily, as shown in Fig. 19B. We found no evidence of diurnal migration, approximately the same proportion of the total numbers having been collected from 0-60 m in the daytime (34%) as at night (35%).

Undinula vulgaris is a characteristic and abundant form of shallow subtropical and tropical oceanic waters. Vervoort (1949) suggested that it, with Euchaeta marina and Labidocera acuta, fills a role in the tropical Indo-Pacific comparable to that of Calanus finmarchicus in northern seas. Perhaps U. vulgaris, E. marina and Clausocalanus furcatus are the substitutes in the tropical Atlantic. We know of no studies of biomass which would confirm or negate the idea.

In the time since Owre & Foyo (1967) summarized records from the western North Atlantic, U. vulgaris has been reported from the Caribbean and the Gulf of Mexico by Kolesnikov (1968), Moryakova (1968), Owre & Foyo (1972) and Park (1969). In addition, a study of the vertical distribution of copepodites and adults in relation to light has been made by Ackefors & Zillioux (1975). Although fairly numerous in our collections, it was the most restricted in vertical distribution and the least frequently caught of the calanoid species counted (Table 33). Grice (1961) suggested that it has neritic tendencies, which could account for the fewer catches since most of our stations were located far from land. However, U. vulgaris was collected in considerable numbers in every broad area sampled during our program, with the exception of the northeastern Gulf of Mexico, at P 6803, Sta. 8, off the Mississippi delta (Table 45). There, the temperature of 21°C at the surface was too cold for it. Perhaps a better explanation of its infrequent capture can be found in the fact that it is known to swarm in huge numbers, even at the surface

in the daytime (personal observations, subsequent to collection of present data), thus occurring in patches. It also occupies rather narrow levels in the upper 100 m, the depths of which are regulated by developmental stage and light, according to Ackefors & Zillioux (1975). Thus, even though it was present at 64 of our stations, it was caught at more than one depth at only 18 of them, unlike the other calanoid species (Table 45). On the 18 occasions, the numbers at one of the two or three depths were much greater than at the others (e.g., P 6606, Sta. 4; P 6701, Sta. 18), with the one exception of those at P 6911, Sta. 4 (60 at 0 m, 50 at 81 m). This lack of vertical spread, with the species almost completely restricted to TSW and SUW, is shown in Fig. 20A.

Diurnal migration of *U. vulgaris* in the Florida Straits has been investigated by Moore & O'Berry (1957), who described it as moderately extensive, Roehr & Moore (1965) and Owre & Foyo (1967). The last authors simply reported its distribution around midday and midnight at two stations in the eastern part of the Straits off Miami. At one station, *U. vulgaris* was collected at 7 levels in 0-227 m, and at the other, 9 levels in 0-274 m. At the first, 85% of the catch came from the upper 40 m at night (60% at the surface), compared with 23% (6.5% at the surface) during the day. However, the diurnal differences were not as pronounced at the second station, where 84% were caught in the upper 32 m at night and 75.5% were between the surface and 26 m near midday. The data indicate that movement away from the surface in daytime and towards it at night may take place by adult males and females but not necessarily in the form of an exodus. At the first station, copepodites constituted the catch (16%) at 38 m in the daytime. These relatively crude studies were followed by the more careful examination of the distribution of *U. vulgaris* made by Ackefors and Zillioux (1975) in the Caribbean Sea, the Antillean Current and the Florida Current. They concluded that "adult males and females...make

diurnal migrations which are closely related to the light intensity. In light intensities less than 100 lux just at the sunset, the adults were concentrated in a dense layer just below surface. Copepodite stage 4 and younger stages including the nauplii were not sensitive to high light intensities and occurred in surface waters at noon." Our results are not in total agreement. In the Caribbean samples, 16% of the catch was collected from the surface in the daytime, and most were adults, occasionally found in large numbers (e.g., P 6904, Sta. 4; P 6911, Sta. 9). Many more formed the night surface catch (46%). In fact, 80% of the total number occurred in the upper 50 m, 28% during the day and 52% at night. The behavior of this numerous, relatively large calanoid ought to be further studied and its position in the biomass evaluated.

Aegisthus aculeatus, the least numerous of all the species counted, was collected in small numbers at many depths over a great vertical range (Tables 30 and 47, Fig. 20B). The few previous records do little to clarify the unusual vertical distribution of this ubiquitous but seemingly uncommon harpacticoid. Grice (1963) reported it from 1000 m at a station in the western North Atlantic east of the Bahama Islands and marked it as a new record for the area south of 45°N and west of 50°W, "...disregarding Wilson's (1942, 1950) records...." Owre & Foyo (1964, 1972) found it in the Yucatan Channel and the western and eastern Caribbean at depths of 877-2385 m and off northeastern South America at 0-1500 m. Although, Owre & Foyo (1967) did not find it in their samples from the Florida Straits, it occurred at nearby stations of the present study (P 6701, Sta. 1; P 6803, Sta. 26; P 6904, Sta. 22).

A. aculeatus was caught less often at depths of 0-999 m than below (57 vs 116 samples), but samples from these depths are the ones in which it was relatively abundant on occasion (0 m and 100 m, P 6606, Sta. 8, 12; 635 m and 676 m, P 6811, Sta. 9 and P 6904, Sta. 9). The numbers at P 6811, Sta. 9

may have resulted from upwelling. The fewer specimens found in the majority of samples form a distinct cluster in lower NACW and SAIW and in NADW in the T-S-P diagram (Fig. 20B).

Macrosetella gracilis is a common harpacticoid throughout the Caribbean and adjacent areas. Owre & Foyo (1967) reviewed records of the species in the western North Atlantic. It and Microsetella rosea were collected from the greatest ranges of salinity and temperature of all the species counted in the present study (Fig. 21). Although it was often found at several levels at a station, the maximum numbers (87% of the total) were living in the upper 115 m (Table 48), regardless of time of day. Roehr & Moore (1965), who included it in a study of vertical distribution in the Florida Straits because of its abundance, concluded that it is "...aberrant in showing no diurnal migration, although deep-living," and they thought it had been inadequately sampled. Regular fluctuations in level and composition of the main body of the population in the upper 100 m would not appear in our data. We can at least say that copepodites and adult males and females were collected at the surface, both day and night, and indeed that no differences in surface samples can yet be ascribed to time of day. Also, if M. gracilis does migrate diurnally, the migration takes place on a very small scale compared with the vertical range of the species.

Microsetella rosea, a harpacticoid more numerous and more frequently caught than any of the calanoids (Table 33), is one of the most interesting species counted, especially as so little is known about it in the Caribbean area and, indeed, in the North Atlantic. The few records from the western North Atlantic, the Florida Straits and the Gulf of Mexico were listed by Owre & Foyo (1967), who identified it in samples from the eastern Florida Current

other than the ones on which they were reporting and who did not find it in early Caribbean collections or those off northeastern South America (Owre & Foyo, (1964, 1972). However, both Kolesnikov (1968) and Moryakova (1968) reported _M. rosea_ from the Gulf of Mexico and the western Caribbean. In a study of copepods off Brazil, Björnberg (1963) found it most abundant in very saline and warm oceanic waters. She also commented that it occurs in swarms and was found in great numbers in the stomachs of some plankton-eating fishes, although it was not very common in the samples perhaps because, owing to its small size, it escaped the nets. Binet & Dessier (1971) listed _Microsetella_ spp. from the Gulf of Guinea off the Congo, noting that _M. norvegica_ and _M. rosea_ had been reported off Angola by several workers. They further wrote (translated from the French), "Some individuals belonging to the two species have been found in a few samples, but it is very probable that the _Microsetella_ ordinarily pass through the meshes of the net." Since the net was the I.C.I.T.A. type of 0.28 mm mesh size, and the species has a size range of 0.60-0.85 mm (Björnberg, 1963; Rose, 1933), one is inclined to doubt the sampling efficiency of the net rather than to accept the explanation of exclusion by size. Populations of _M. rosea_ may well constitute a considerable portion of the subtropical and tropical seston biomass.

M. rosea was most numerous in TSW, SUW and even in upper NACW. It also occurred frequently, though in small numbers, in lower NACW and SAIW and in NADW, to the bottom of our collecting range (Fig. 21B). It was often caught at many or all of the depths sampled at a station, but the maximum numbers of this species are concentrated, day and night, in the upper 115 m in the Caribbean, 93% of the specimens having been collected in that range (Table 49).

The cyclopoid Conaea gracilis was one of the more frequently caught species, although not one of the very numerous ones (Table 33). Since Owre & Foyo (1967) summarized western North Atlantic records of this species, which they found only once in samples from the Florida Current, Kolesnikov (1968) and Moryakova (1968) both reported it, as Conaea rapax Giesbrecht. The vertical range known at that time was 250-1750 m (Owre & Foyo, 1964). The latter authors (1972) found it the more numerous cyclopoid species at several depths from 435 to 2385 m at stations in the Yucatan Channel and the Caribbean and also at 500 and 1500 m off northeast South America, with the highest percentages collected at 1000 m and below. A somewhat different distributional picture, including a vertical range of 0-5200 m, emerged from the results of repeated sampling in the Caribbean over a broad depth range. It occurred in maximum numbers between approximately 500 and 1000 m, with smaller numbers regularly collected at greater depths (Table 51). The infrequent shallower records can be linked with upwelling (P6606, Sta. 11, 12) or, in the case of the unusual surface catches at P 6701, Sta. 14 and 16, which are late January and early February samples from the eastern Caribbean, possibly with winter mixing in the equatorial regions to the south. The distribution of C. gracilis, mainly in NACW and SAIW, but extending from cool TSW to NADW, is shown in Fig. 22A.

Farranula carinata has been recorded many times from the western North Atlantic, the Gulf of Mexico, the Florida Straits and the Caribbean (Owre & Foyo, 1967, 1972; Moryakova, 1968). Moryakova collected it in the upper 200 m in the central and eastern Caribbean while Owre & Foyo (1972) caught it only at the surface. The second most numerous copepod species counted in our samples, it had a great vertical range but the maximum numbers were always caught in TSW (Tables 33 and 52, Fig. 22B). Our data suggest that swarms of males and

females live just beneath the surface. It was never numerous below approximately 50 m. Short range vertical movements in response to light may be indicated by the fact that the largest numbers, 10,000 and above, were always collected in the surface net at night or twilight, with one exception at midday (P 6811, Sta. 12) and one in mid-afternoon (P 6811, Sta. 3).

Farranula gracilis, the least numerous and most infrequently caught species individually counted (Tables 33 and 53), has been listed by several authors writing about the Caribbean area since Owre (1962) first reported it, as Corycella gracilis, from the Florida Current (Owre & Foyo, 1967, 1972; Kolesnikov, 1968; Moryakova, 1968). However, we know of no reports of this species from the Gulf of Mexico nor did we find it there. Judging from Owre & Foyo's (1972) records of F. gracilis in the Yucatan Channel, the Caribbean and the Atlantic off northeastern South America, it is even more numerous and widely dispersed than F. carinata. This happens to be true near the equator but not in the Caribbean, and the erroneous conclusion is another example of a mistake derived from few data collected in a broad and varied area. Björnberg (1963) found it the first or second most numerous copepod species off Brazil, south the of Amazon outflow, and a good indicator of warm, saline water (>21°C and >35.5°/oo). Binet & Dessier (1971) also reported it as numerous in warm, saline waters in the Gulf of Guinea. Neither they nor Björnberg found F. carinata in their areas of study. Thus, F. gracilis is an oceanic organism whose populations are centered in the equatorial regions, although it is widely distributed by surface currents throughout the Caribbean and it was collected twice in the Yucatan Channel (P 6805, Sta. 2; P 6811, Sta. 20). It also occurred in numerous samples from the Antillean Current (G 6722, Sta. 10, 12; P 6904, Sta. 15, 16, 20, 21, 22; P 6911, Sta. 15, 17).

Our data indicate that it prefers even warmer water than Björnberg described as it was rarely caught at temperatures below 25°C (Fig. 23A). The few specimens collected in NADW may have been contaminants. Like _F. carinata_, swarms of males and females live just beneath the surface, where 71% of the collections were made.

F. gracilis appears to have potential as an indicator of shallow water from oceanic equatorial regions and the Equatorial Currents, judging from the reports of Björnberg and Binet & Dessier and our own findings. Björnberg has already observed that it becomes rare or disappears in cold waters, is rare in coastal waters, and "although small, when in large numbers it is a good indicator of very saline, warm waters, because of its bright colour (blue, when kept in formalin)." The few records north of 25°, in the North Atlantic and Florida Straits, and its absence from the Gulf of Mexico suggest that its presence in those areas could be regarded as an indication of equatorial water. Further study of the species and the hydrography in the areas of concentration and peripherally, where it remains relatively abundant, could well show that it is a tag labeling equatorial current water entering the Caribbean through various passages and also flowing north in the Antillean Current. There are possibly areas in the Caribbean where populations of _F. gracilis_ exist and reproduce, e.g., the Cariaco Trench (Legaré, 1964), the Central American bight (P 6606, Sta. 11-14) and the extreme western Caribbean (P 6803, Sta. 15-18), but without quantitative data the status of the collections cannot reliably be assessed.

Oithona plumifera, the most numerous and frequently collected of those copepod species individually counted (Table 33), was abundant over a greater range of temperature and salinity than any of the others (Fig. 23B). Its

T-S-P diagram resembles that of Microsetella rosea (Fig. 21B). It is a broadly distributed species, eurythermal and euryhaline (Björnberg, 1963; Kolesnikov, 1968; Moryakova, 1968; Owre & Foyo, 1967, 1972). The maximum numbers of O. plumifera were collected in the upper 100-150 m in the Caribbean (Table 54), mostly in subsurface catches. At the 80 stations where it was collected both at the surface and in subsurface tows, it was most abundant at the surface at only 10, equally divided between night and day. Roehr & Moore (1965) observed that it apparently performs a reversed diurnal migration. The present data only show that O. plumifera is possibly the most numerous oceanic copepod species in the Caribbean and adjacent areas and that it ordinarily lives within a few meters of the surface, probably fluctuating in depth according to light intensity.

The records of Oncaea mediterranea in the western North Atlantic and neighboring regions were summarized by Owre & Foyo (1967). It has since been reported from the Caribbean and the Gulf of Mexico by Kolesnikov (1968), Moryakova (1968) and Owre & Foyo (1972), who also found it a relatively abundant species off Brazil north of the equator. Earlier, Björnberg (1963), listing the species with a question mark, reported that the largest number was found in "...very saline, cold, southern, surface waters" and then observed that it is eurythermal with its optimum environment in temperate waters. However, in the Caribbean samples, it was similar in abundance to Haloptilus longicornis, Lucicutia flavicornis and Rhincalanus cornutus f. atlantica, all wide-ranging forms in the temperate and tropical North Atlantic (Table 33). It is a eurythermal, euryhaline species, most numerous in subsurface collections in the upper 250 m, day and night, but the bulk of the population seems to avoid the top layer sampled by the surface net (Table 55, Fig. 24A).

Oncaea venusta was more frequently caught and more than twice as numerous as O. mediterranea in the Caribbean (Table 33). The same authors who reported O. mediterranea also reported O. venusta as a common species, but the latter was less numerous and caught less often in the Caribbean and the North Atlantic by Owre & Foyo (1972). Björnberg (1963) found it more abundant in tropical and subtropical oceanic surface waters than in coastal areas and "a good indicator because of its colour and large numbers." During our investigation, maximum numbers were collected in the upper 100-150 m at most stations, often in the surface net in both day and night tows (Table 56). No consistent relationship of depth and numbers to light is seen in the data. For example, it was more numerous at 60 m than at the surface in the daytime at P 6911, Sta. 8 and just the opposite at Sta. 9. It thus differs in habit from O. mediterranea, which tends to avoid the layer sampled by the surface net. Its broad vertical distribution, with the majority of specimens found in TSW and SUW, is shown in Fig. 24B.

The horizontal distribution of copepods is similar to that of chaetognaths, which were far less numerous but still the second most abundant organisms studied in our collections. Copepods were present at all depths sampled at all stations. The numerical summary in Table 34, the distribution of numbers at those selected stations diagrammed in Fig. 25 and at all stations, in Fig. 26 show relatively low average numbers at those stations selected as representative of passages, including those in the Yucatan Channel. On the other hand, great abundance was registered at G 6722, Sta. 12, north of Barbados (Fig. 26). This and other large collections on either side of the Lesser Antilles, made on G 6722 and P 6911 (Figs. 9 and 10) in early December and in October-November, respectively, may reflect high productivity in relation to the wet season. Copepods were most abundant in the central

and western Caribbean as well as in areas of upwelling off South and Central America. In addition, high productivity is indicated by the large numbers collected in the Gulf of Mexico at P 6803, Sta. 8, off the Mississippi delta (Fig. 26). The hydrographic data from this station (Table 16) show the influence of the Mississippi River and also indicate mixing since the densities at the four levels sampled are nearly uniform.

The 20 copepod species individually counted occur throughout the areas sampled with one exception. The distribution of _Farranula gracilis_, which was not collected in the Gulf of Mexico, has already been discussed. Also, those primarily meso- and bathypelagic species, e.g., _Mormonilla minor_, _M. phasma_ and _Conaea gracilis_, may not ordinarily be found in shallow areas such as those sampled at P 6803, Sta. 4 and 5.

TABLE 34

Data on horizontal distribution of copepods, summarized from Table 23.

Location	No. of Stations	Range in No. Copepods Collected	Average of Total No. Collected per Station
Yucatan Channel	4	34, 874-117, 780	66,943
Western Caribbean	8	40, 752-184, 323	81,422
Central Caribbean	6	47, 156-198, 608	98,953
Eastern Caribbean	14	17, 108-106, 718	59,882
Areas of Upwelling	12	25, 824-177, 904	91,355
Passages	4	7, 966-90, 261	51,618

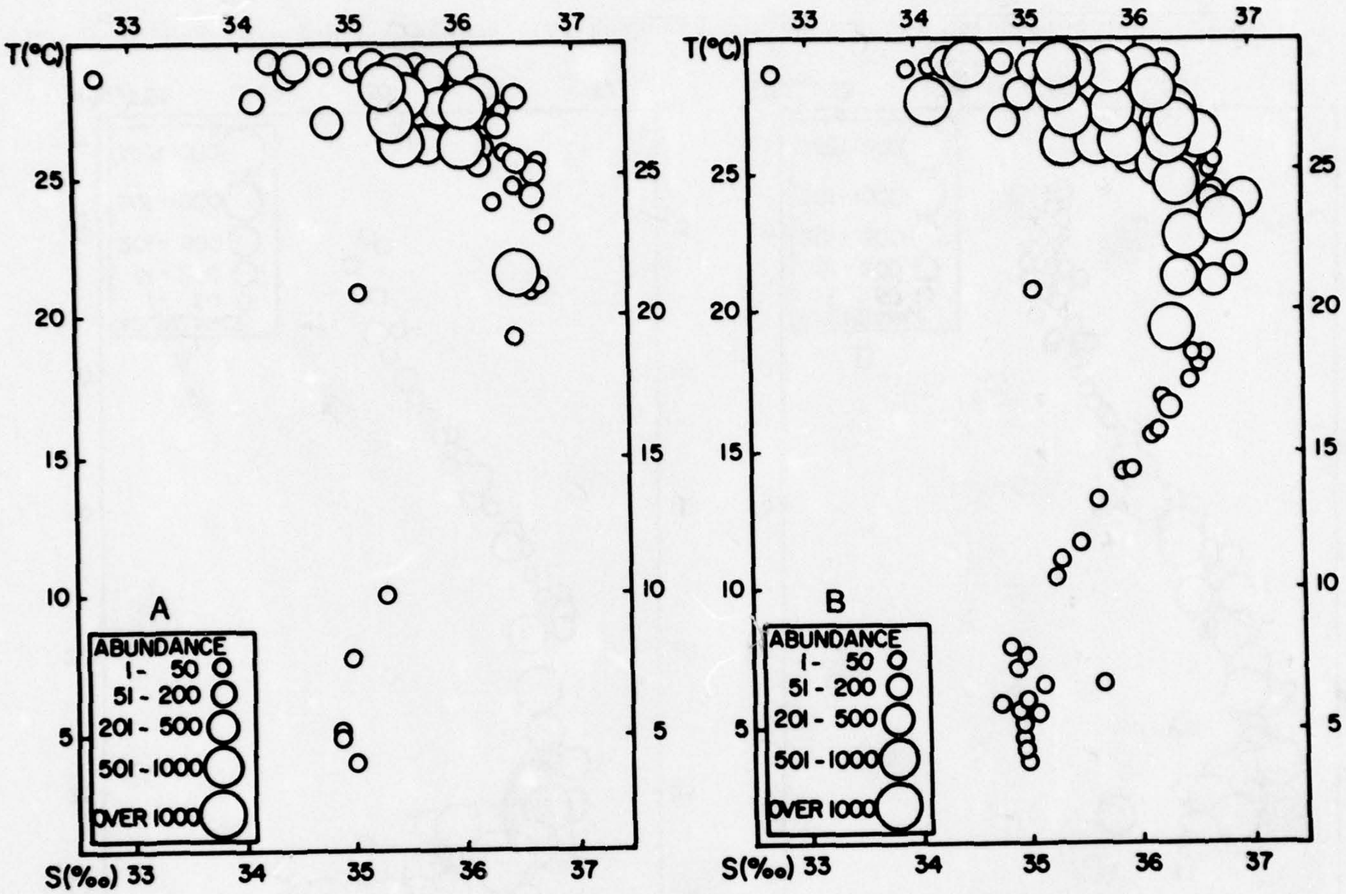

Figure 15. T-S-P diagrams, (A) Acrocalanus longicornis and (B) Clausocalanus furcatus

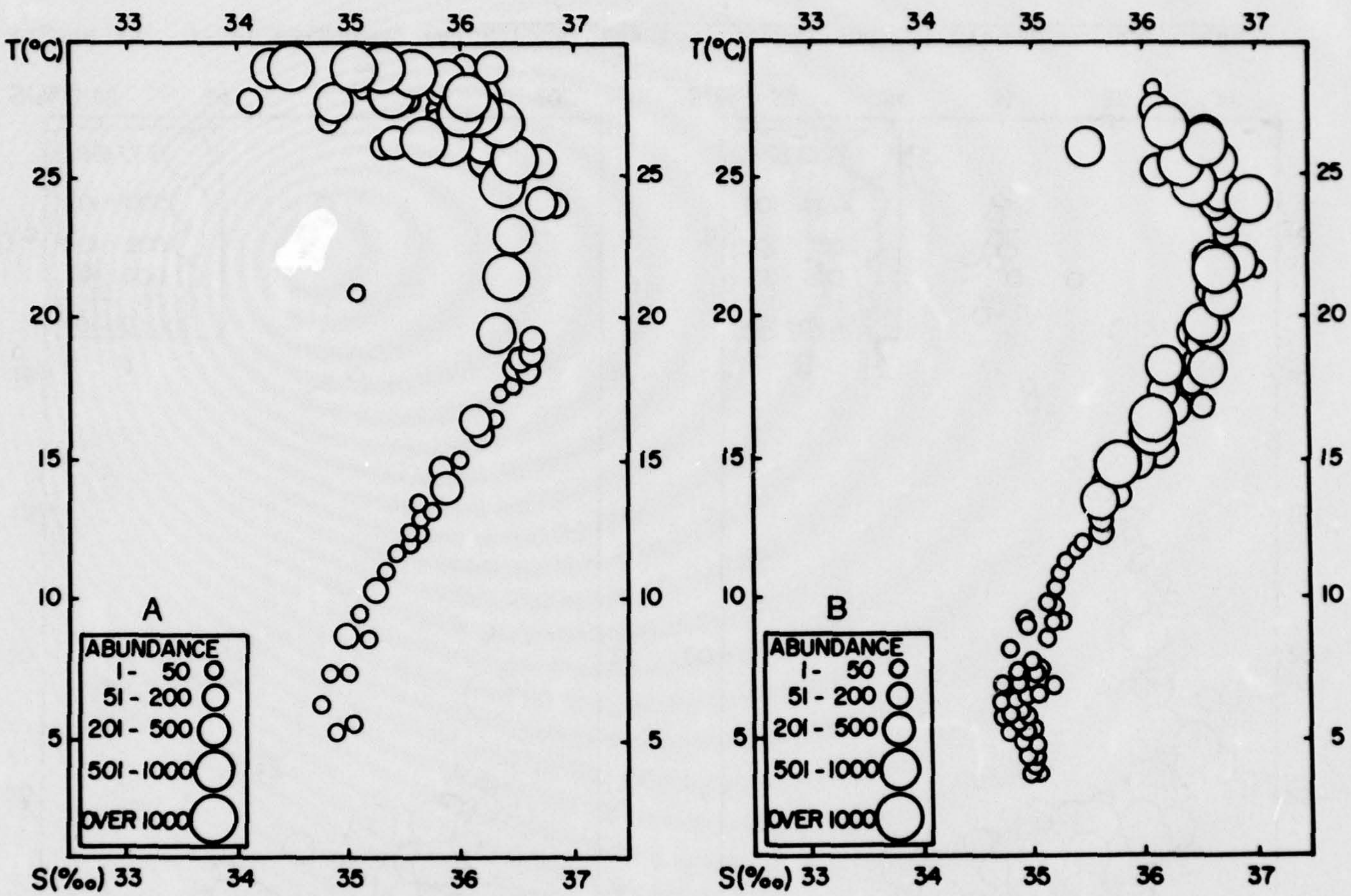

Figure 16. T-S-P diagrams, (A) <u>Euchaeta marina</u> and (B) <u>Haloptilus longicornis</u>

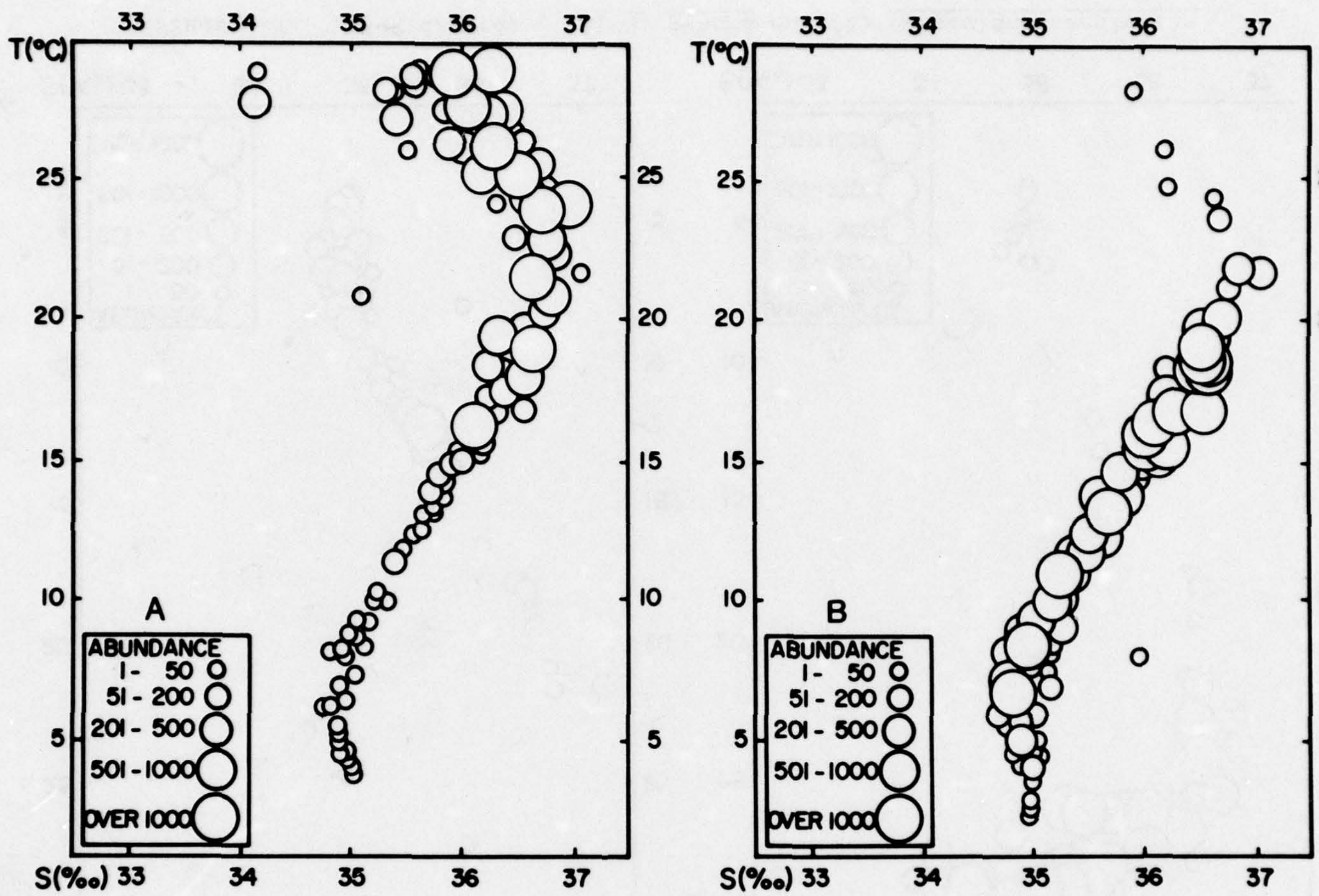

Figure 17. T-S-P diagrams, (A) Lucicutia flavicornis and (B) Mormonilla minor

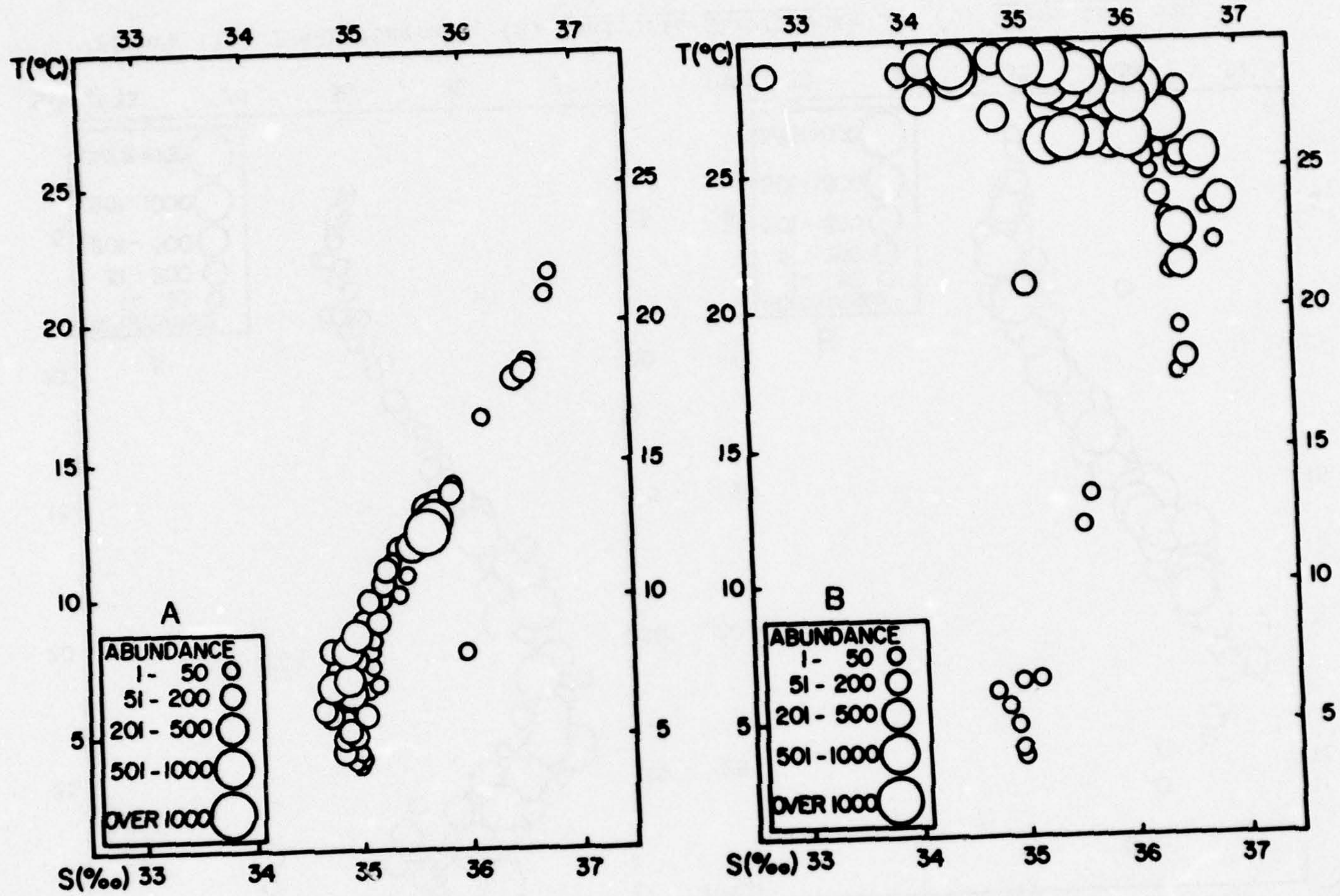

Figure 18. T-S-P diagrams, (A) M. phasma and (B) Paracalanus aculeatus

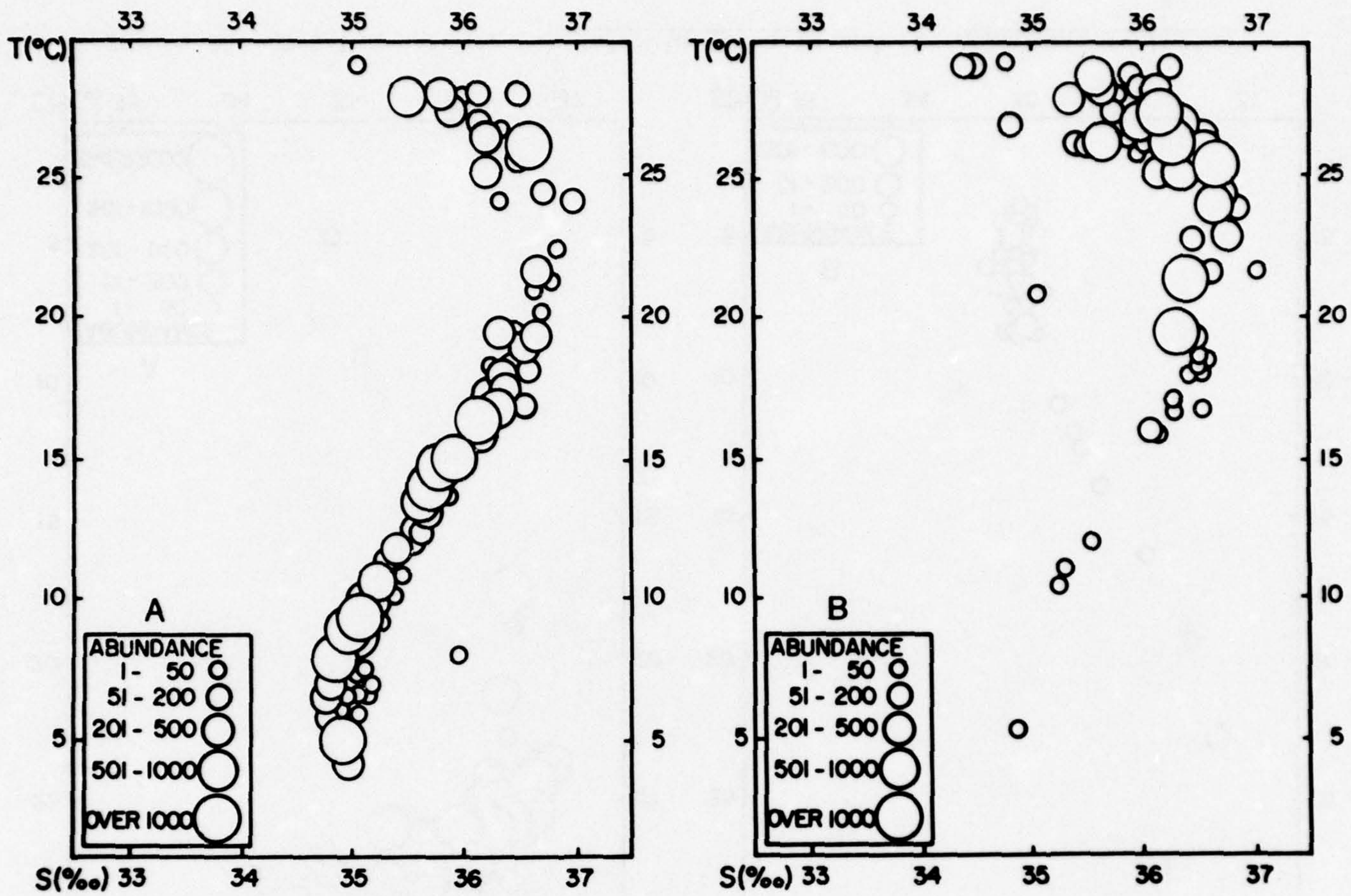

Figure 19. T-S-P diagrams, (A) Rhincalanus cornutus and (B) Scolecithrix danae

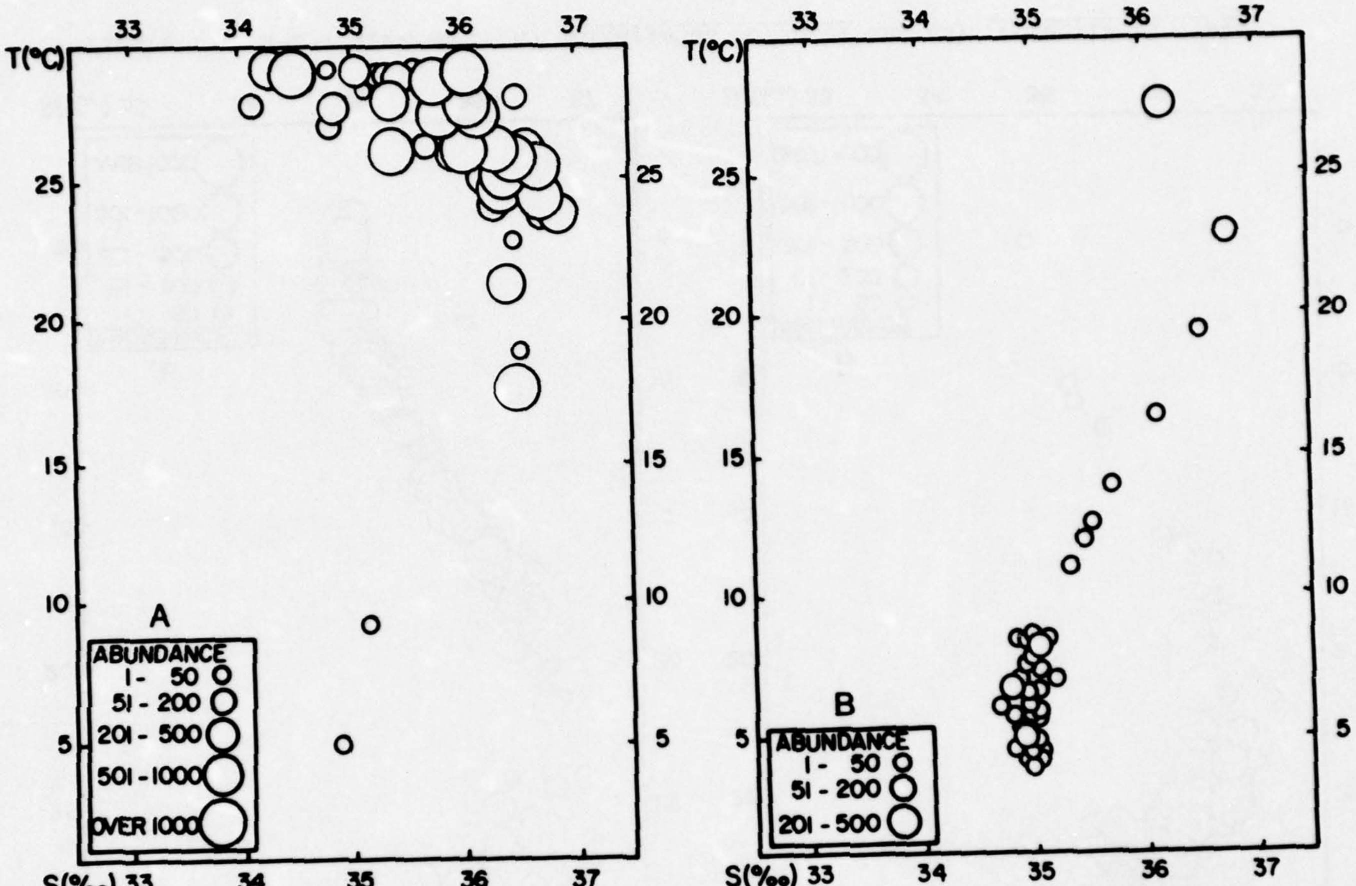

Figure 20. T-S-P diagrams, (A) Undinula vulgaris and (B) Aegisthus aculeatus

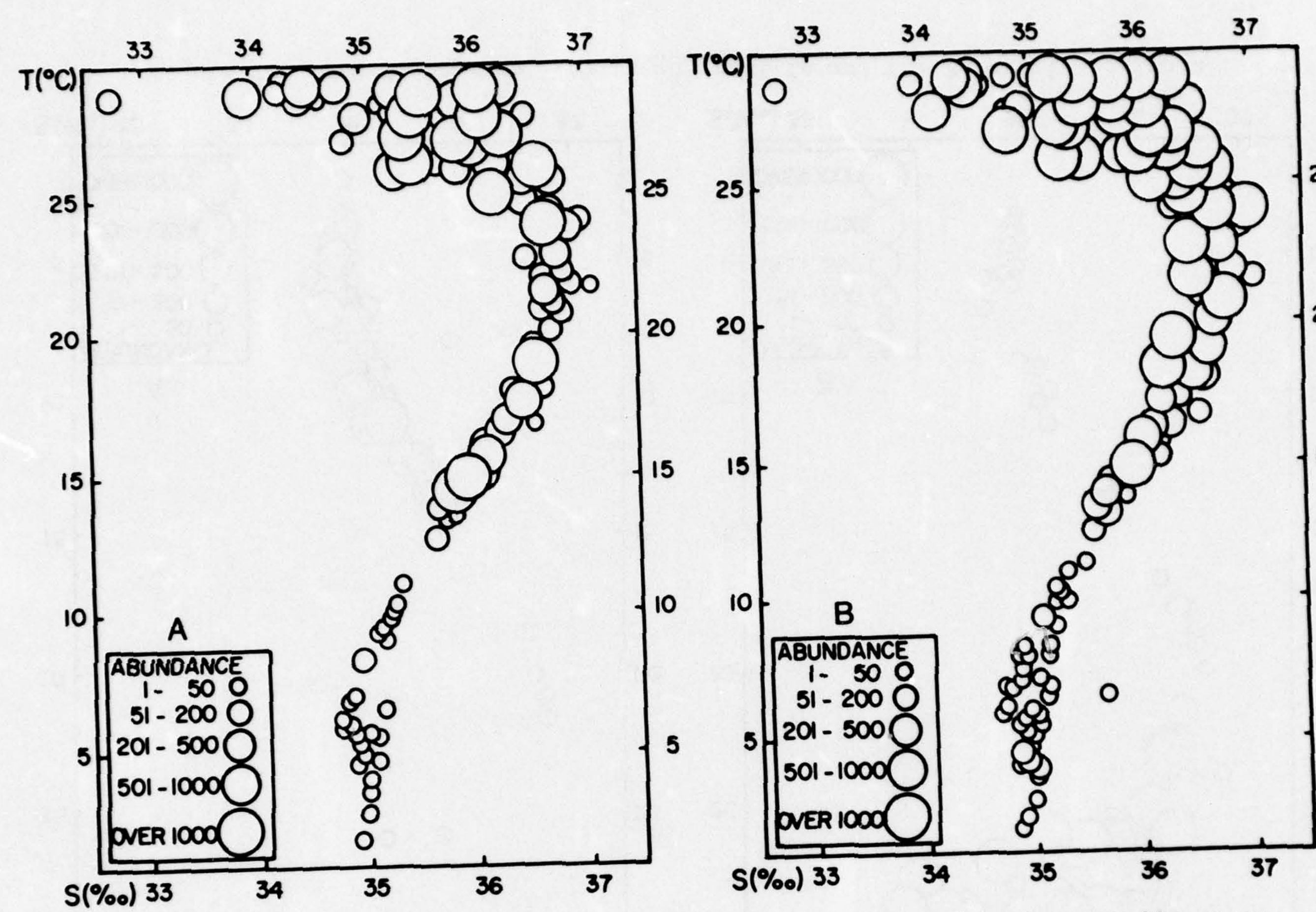

Figure 21. T-S-P diagrams, (A) *Macrosetella gracilis* and (B) *Microsetella rosea*

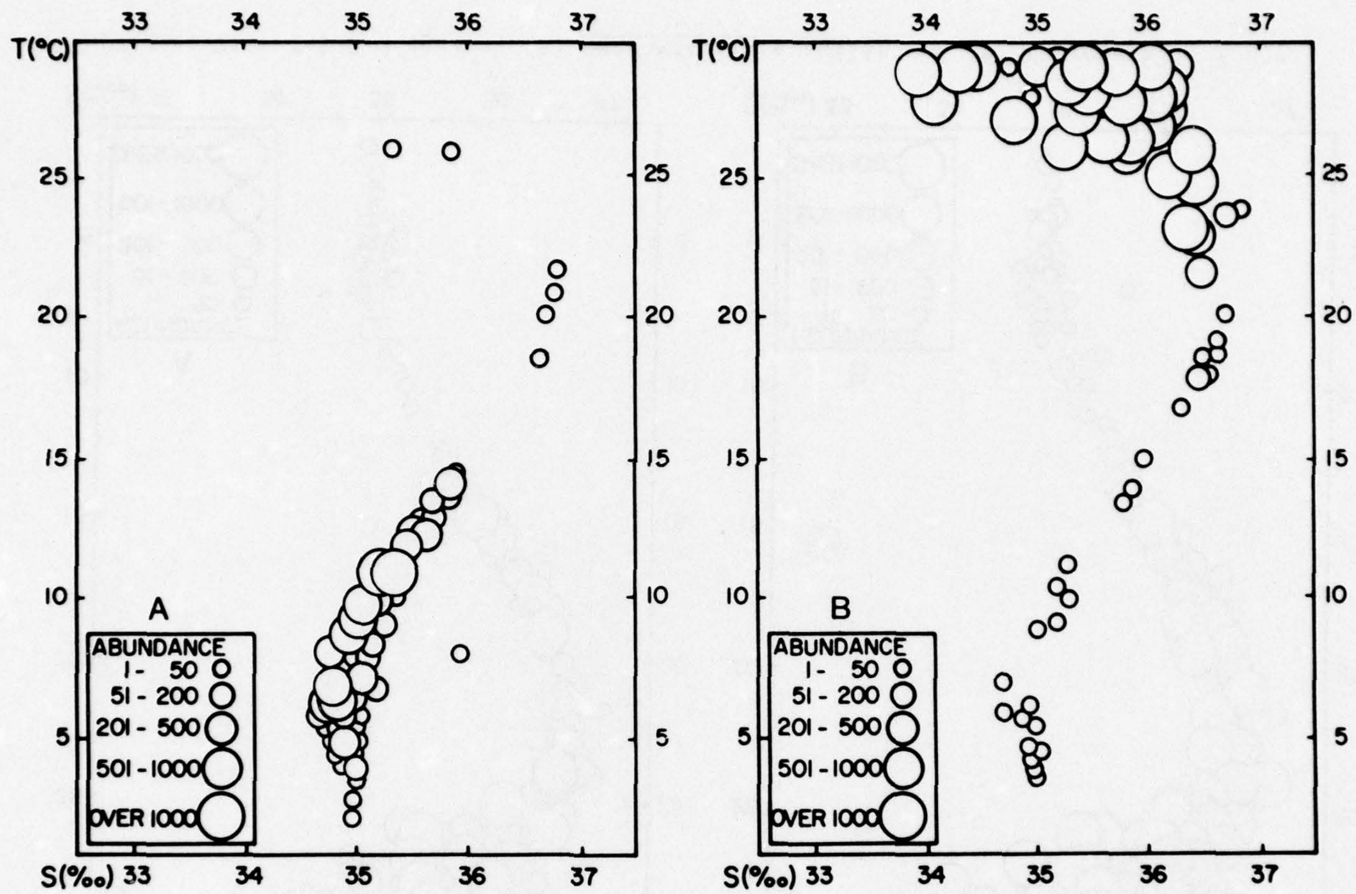

Figure 22. T-S-P diagrams, (A) Conea gracilis and (B) Farranula carinata

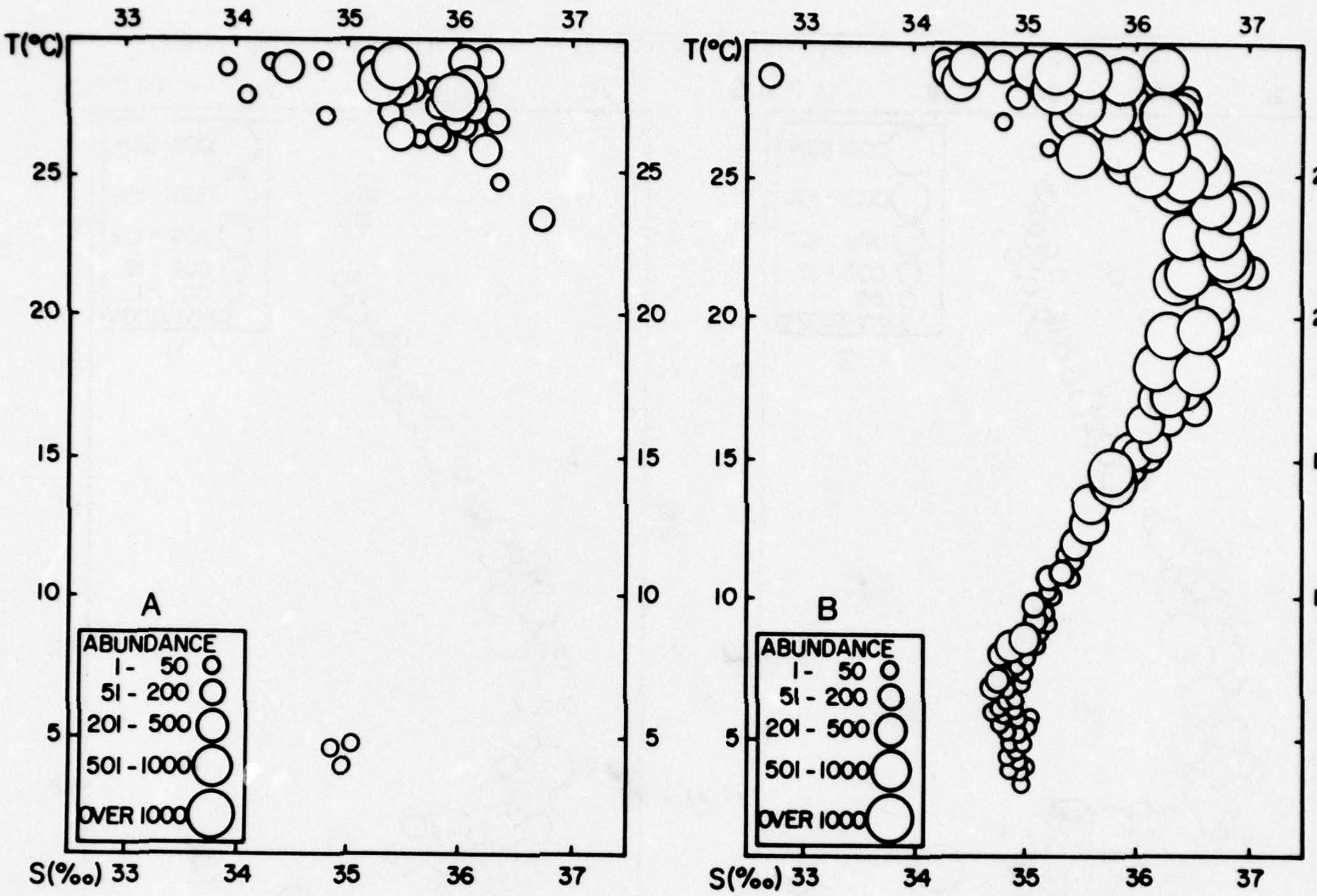

Figure 23. T-S-P diagrams, (A) F. gracilis and (B) Oithona plumifera

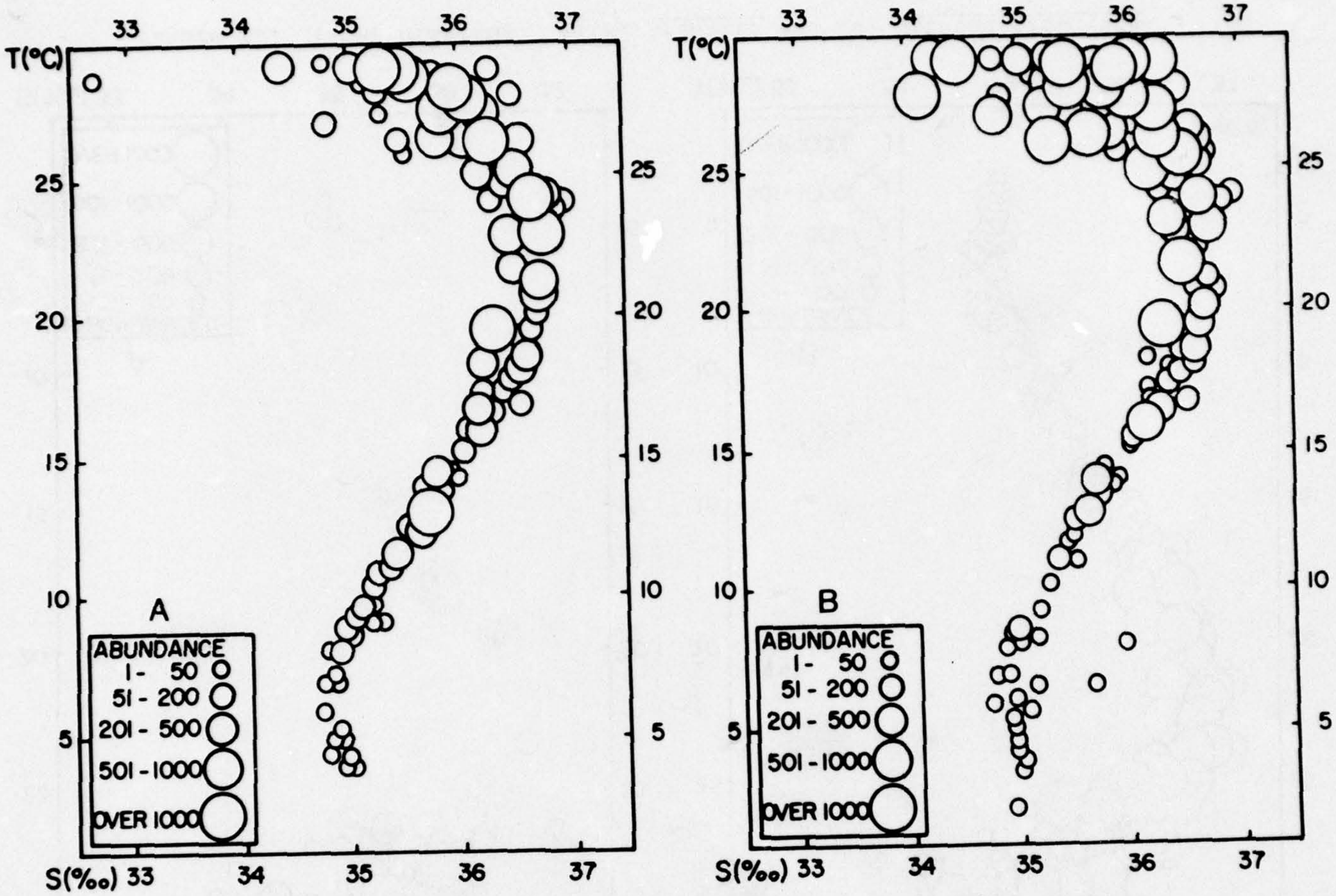

Figure 24. T-S-P diagrams, (A) <u>Oncaea mediterranea</u> and (B) <u>O. venusta</u>

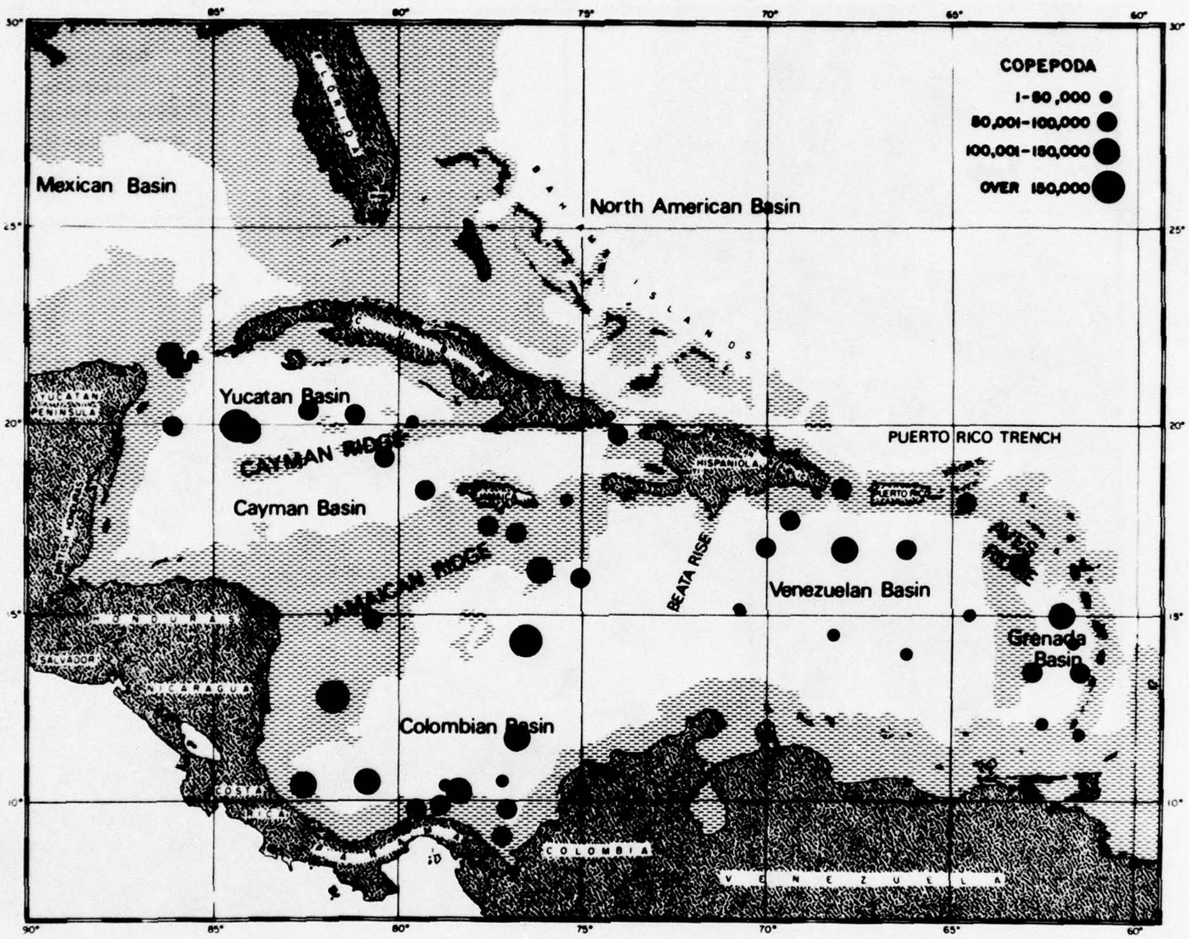

Figure 25. Total numbers of Copepoda collected at 48 stations selected to compare abundance in major Caribbean areas (see Table 23)

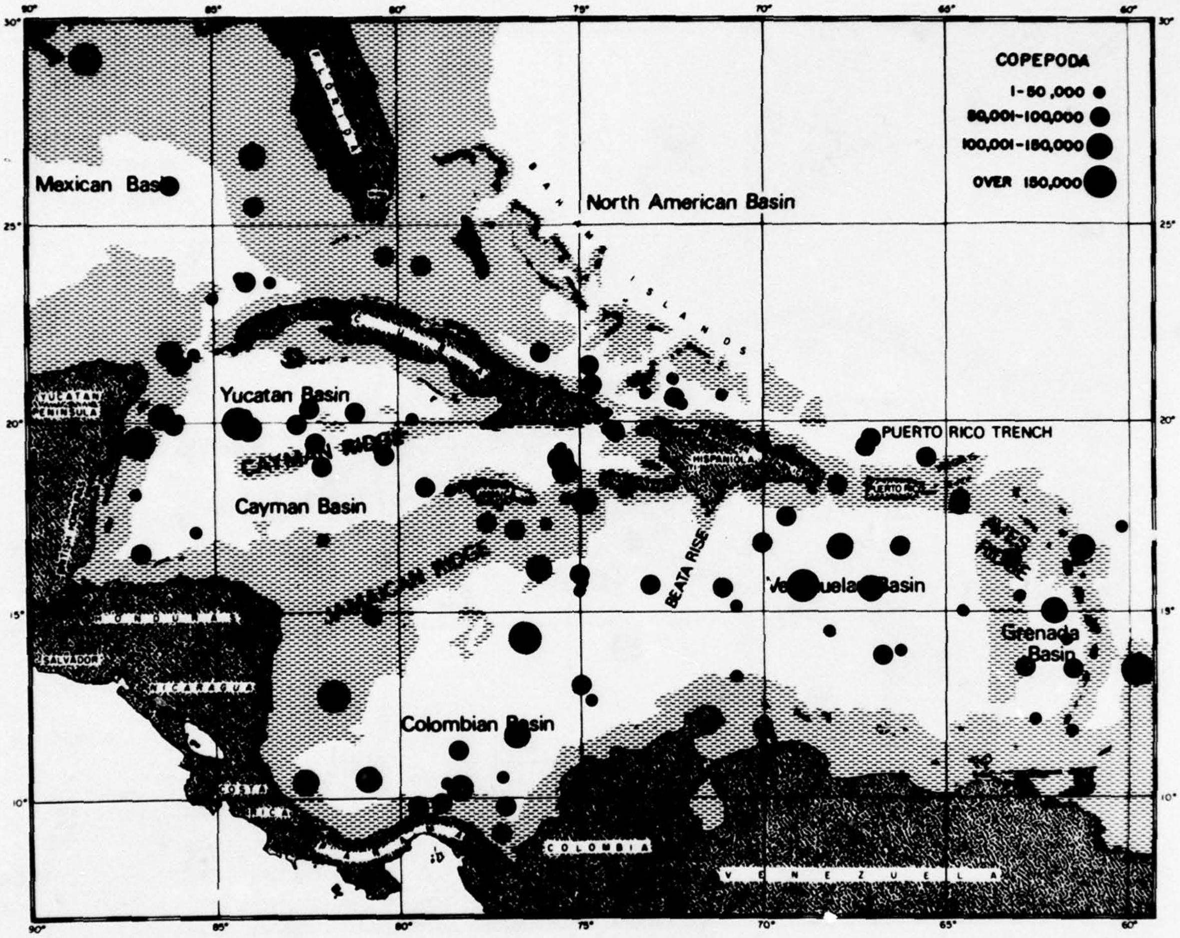

Figure 26. Total numbers of Copepoda collected at all stations

TABLE 35

Vertical distribution of <u>Acrocalanus longicornis</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6606	8	0	50♀	100.0
	12	0	550♀	100.0
	13	0	250♀	100.0
	14	10	50♀	100.0
P-6701	2	0	5♀	100.0
	5	0	300♀	96.8
		250	10♀	3.2
	8	0	1000♀	100.0
	10	110	100♀	95.2
		1800	5♀	4.8
	11	110	100♀	99.0
		1800	1♀	1.0
	12	0	30♀	96.8
		1450	1♀	3.2
	13	0	1150♀	100.0
	14	0	400♀	99.8
		1650	1♀	0.2
	16	0	150♀	100.0
	18	0	550♀	99.8
		1000	1♀	0.2
	24	0	100♀	100.0
G-6722	4	0	100♀	14.3
		55	600♀	85.7
	9	0	2950♀	99.9
		562	1♀	0.0
		1200	1♀	0.0
	10	0	350♀	100.0
	12	0	800♀	100.0
	15	0	120♀	100.0
	17	0	160♀	100.0
P-6803	4	0	40♀	100.0
	5	0	1100♀	95.7
		40	50♀	4.3
	8	0	80♀	100.0
	16	0	40♀	100.0

TABLE 35 (continued)

Vertical distribution of Acrocalanus longicornis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	17	0	300♀	100.0
	18	0	30♀	100.0
	20	0	10♀	11.1
		75	60♀	66.7
		125	20♀	22.2
P-6805	2	0	750♀	100.0
	3	0	350♀	100.0
	5	96	20♀	100.0
	7	0	100♀	100.0
	10	0	50♀	100.0
P-6811	1	0	350♀	100.0
	2	0	10♀	100.0
	3	0	2600♀	100.0
	4	0	1300♀	100.0
	5	0	300♀	100.0
	6	0	250♀	100.0
	11	0	250♀	100.0
	15	0	50♀	100.0
	19	0	300♀	100.0
P-6904	1	0	1950♀	100.0
	2	0	1050♀	77.8
		14	300♀	22.2
	3	30	1100♀	100.0
	4	0	60♀	14.3
		30	360♀	85.7
	5	21	350♀	100.0
	6	0	100♀	100.0
	9	0	5♀	5.9
		70	80♀	94.1
	11	0	150♀	58.8
		45	100♀	39.2
		759	5♀	2.0
	12	0	210♀	25.9
		30	600♀	74.1
	13	0	150♀	50.0

TABLE 35 (continued)

Vertical distribution of <u>Acrocalanus</u> <u>longicornis</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		48	150♀	50.0
	15	52	50♀	100.0
	16	59	200♀	100.0
	17	45	20♀	100.0
	19	30	50♀	100.0
P-6911	1	0	30♀	100.0
	2	53	50♀	100.0
	3	0	2♀	1.0
		60	200♀	99.0
	4	0	40♀	100.0
	5	0	20♀	6.9
		59	270♀	93.1
	6	0	20♀	2.0
		50	1000♀	98.0
	7	0	24♀	54.5
		60	20♀	45.5
	9	0	250♀	71.0
		60	100♀	28.4
		2088	1♀	0.3
		2454	1♀	0.3
	10	0	100♀	24.9
		56	300♀	74.6
		975	2♀	0.5
	11	0	200♀	80.0
		58	50♀	20.0
	12	36	40♀	100.0
	13	0	100♀	100.0
	14	0	60♀	28.6
		34	150♀	71.4
	15	0	150♀	42.9
		53	200♀	57.1
	16	0	30♀	42.9
		51	40♀	57.1
	17	0	20♀	28.6
		54	50♀	71.4

TABLE 36

Vertical distribution of Clausocalanus furcatus

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6606	4	103	1500♀	100.0
	8	0	50♀	25.0
		100	150♀	75.0
	11	0	150♀	100.0
	12	0	16500♀	99.4
		100	100♀	0.6
	13	0	250♀	100.0
	14	10	250♀	100.0
P-6701	1	0	30♀	100.0
	2	0	235♀	99.2
		575	2♀	0.8
	3	0	50♀	90.9
		115	5♀	9.1
	4	0	25♀	100.0
	5	0	3150♀	82.9
		90	650♀	17.1
		860	2♀	0.1
	8	0	13900♀	99.6
		70	12♀	0.1
		250	40♀	0.3
	10	0	6♀	2.8
		110	200♀	94.3
		2200	6♀	2.8
	11	0	2♀	2.4
		110	50♀	58.8
		975	6♀	7.1
		1525	7♀	8.2
		1800	11♀	12.9
		2375	9♀	10.6
	12	0	30♀	34.1
		100	50♀	56.8
		920	2♀	2.3
		1825	2♀	2.3
		3200	4♀	4.5
	13	0	850♀	100.0
	14	0	4350♀	99.8
		500	4♀	0.1

TABLE 36 (continued)

Vertical distribution of Clausocalanus furcatus

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1650	1♀	0.0
		2150	3♀	0.1
	16	0	450♀	98.3
		398	6♀	1.3
		775	2♀	0.4
	18	0	400♀	41.5
		100	550♀	57.1
		1000	8♀	0.8
		1625	2♀	0.2
		2200	2♀	0.2
		4350	1♀	0.1
	20	850	1♀	50.0
		1050	1♀	50.0
	22	1650	5♀	35.7
		2000	8♀	57.1
		2350	1♀	7.1
	24	2600	1♀	33.3
		3000	2♀	66.7
G-6722	4	0	2950♀	52.6
		55	2650♀	47.3
		335	5♀	0.1
	9	0	6100♀	78.7
		40	1650♀	21.3
		875	1♀	0.0
	10	0	300♀	98.7
		1800	4♀	1.3
	12	0	2550♀	43.5
		80	3300♀	56.2
		181	10♀	0.2
		310	4♀	0.1
		675	2♀	0.0
		1150	2♀	0.0
	15	0	60♀	63.8
		30	30♀	31.9
		132	3♀	3.2
		450	1♀	1.1
	17	0	40♀	59.7

TABLE 36 (continued)

Vertical distribution of Clausocalanus furcatus

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		55	20♀	29.9
		2000	7♀	10.4
P-6803	4	0	20♀	1.4
		30	1400♀	97.9
		100	10♀	0.7
	5	0	300♀	100.0
	8	0	20♀	1.9
		40	1050♀	98.1
	11	0	40♀	5.8
		30	650♀	94.2
	15	0	40♀	100.0
	16	0	300♀	98.7
		1000	2♀	0.7
		1500	1♀	0.3
		3000	1♀	0.3
	17	0	4350♀	100.0
	18	0	60♀	100.0
	20	0	30♀	14.3
		75	100♀	47.6
		125	80♀	38.1
	22	0	130♀	59.1
		200	90♀	40.9
	26	150	1♀	100.0
P-6805	2	0	2450♀	94.6
		100	100♀	3.9
		250	40♀	1.5
	3	0	9500♀	99.5
		100	50♀	0.5
	4	0	2550♀	100.0
	9	65	150♀	99.3
		1438	1♀	0.7
P-6811	1	0	1350♀	79.4
		38	350♀	20.6
	2	0	10♀	6.2
		77	150♀	93.7

TABLE 36 (continued)

Vertical distribution of Clausocalanus furcatus

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	3	0	100♀	96.2
		63	2♀	1.9
		1450	2♀	1.9
	4	0	200♀	66.7
		50	100♀	33.3
	5	0	2000♀	100.0
	6	0	600♀	42.9
		25	800♀	57.1
	7	0	30♀	100.0
	8	0	450♀	100.0
	9	875	1♀	100.0
	11	0	850♀	85.0
		45	150♀	15.0
	12	0	250♀	100.0
	14	0	750♀	62.4
		40	450♀	37.5
		1175	1♀	0.1
	16	0	300♀	31.6
		52	650♀	68.4
	17	0	30♀	100.0
	18	0	4650♀	86.9
		114	700♀	13.1
		1900	1♀	0.0
	19	0	500♀	100.0
	20	0	270♂♀	64.3
		75	150♀	35.7
P-6904	1	0	1000♀	66.6
		38	500♀	33.3
		215	2♀	0.1
	2	0	1650♂♀	42.9
		14	2200♀	57.1
	3	0	50♀	2.0
		30	2450♀	98.0
	4	0	120♀	50.0
		30	120♂♀	50.0
	5	0	60♀	8.5
		21	650♀	91.5

TABLE 36 (continued)

Vertical distribution of Clausocalanus furcatus

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	6	0	350♀	87.5
		31	40♀	10.0
		418	3♀	0.7
		2575	3♀	0.7
		3144	3♀	0.7
		3594	1♀	0.2
	9	0	20♀	50.0
		70	20♀	50.0
	10	30	990♀	98.5
		981	8♀	0.8
		1892	5♀	0.5
		2394	2♀	0.2
	11	0	16200♀	87.2
		45	2350♀	12.7
		524	20♀	0.1
	12	30	8350♀	100.0
	13	0	400♀	79.5
		48	100♀	19.9
		3474	3♂♀	0.6
	14	0	20♀	25.0
		37	60♀	75.0
	15	0	30♀	1.0
		52	3050♀	98.8
		261	6♀	0.2
		2248	1♀	0.0
	16	0	18♂♀	100.0
	17	0	90♀	60.0
		45	60♀	40.0
	18	0	20♀	87.8
		1033	2♀	8.7
		1532	1♀	4.3
	19	0	10♀	3.2
		30	300♀	96.5
		1583	1♀	0.3
	20	0	10♀	0.5
		10	2000♀	99.5
		258	1♀	0.0
	21	0	20♀	0.5

TABLE 36 (continued)

Vertical distribution of Clausocalanus furcatus

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		50	4250 ♀	99.5
	22	40	2300 ♀	96.2
		252	90 ♀	3.8
P-6911	1	0	300 ♀	100.0
	2	0	100 ♀	28.6
		53	250 ♀	71.4
	3	60	11800 ♀	100.0
		1567	3 ♀	0.0
		2072	1 ♀	0.0
	4	0	20 ♂	5.3
		81	350 ♀	93.6
		1844	4 ♀	1.1
	5	59	30 ♀	93.7
		1878	2 ♀	6.2
	6	0	20 ♀	1.5
		50	1350 ♀	98.4
		240	2 ♀	0.1
	7	0	8 ♀	3.7
		60	180 ♀	82.2
		253	30 ♀	13.7
		1000	1 ♀	0.5
	8	0	6 ♀	0.8
		60	750 ♀	98.3
		995	2 ♀	0.3
		2088	4 ♀	0.5
		3304	1 ♀	0.1
	9	0	4600 ♀	77.3
		60	1350 ♀	22.7
		2088	3 ♀	0.1
	10	0	450 ♀	23.6
		56	1450 ♀	76.2
		975	4 ♀	0.2
	11	0	250 ♀	11.4
		58	1950 ♀	88.6
	12	0	15 ♀	9.7
		36	140 ♀	90.3
	13	0	300 ♀	6.6
		65	4250 ♀	93.4
	14	0	30 ♀	1.5
		34	1950 ♀	98.1

TABLE 36 (continued)

Vertical distribution of <u>Clausocalanus furcatus</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		265	1♀	0.1
		785	5♀	0.3
		954	2♀	0.1
	15	0	960♀	41.4
		53	1360♀	58.6
	16	0	270♀	27.3
		51	720♀	72.7
	17	0	20♀	2.6
		54	750♀	97.4

TABLE 37

Vertical distribution of Euchaeta marina

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER		PER CENT
P-6606	4	0	2200♂♀	imm.	88.0
		103	300♀		12.0
	8	0	200♀		50.0
		100	150♀		37.5
		500	50♀		12.5
	12	0	100♂♀		100.0
	13	500	60♂♀		100.0
P-6701	3	0	390♂♀	imm.	97.5
		350	10♀		2.5
	4	0	190♂♀	imm.	99.5
		130	1♀		0.5
	5	0	1150♂♀	imm.	100.0
	8	0	12900♂♀	imm.	100.0
	10	0	3♀		0.1
		110	3550♂♀	imm.	99.9
	12	100	450♂♀		100.0
	13	100	50♂		100.0
	14	0	150	imm.	50.0
		100	150♀		50.0
	16	100	220♂♀		100.0
	18	0	450♀	imm.	100.0
G-6722	4	0	150♀		93.7
		335	10♀		6.2
	9	40	50♀		100.0
	10	45	70♂♀	imm.	100.0
	12	181	10♀		100.0
	15	0	100♀	imm.	83.3
		30	20♀		16.7
P-6803	4	0	120♀		11.2
		30	950♀	imm.	88.8
	8	0	20♀		1.1
		40	1850♀	imm.	98.9
	11	30	5450♂♀		100.0
	17	0	200♀		87.0

TABLE 37 (continued)

Vertical distribution of <u>Euchaeta marina</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER		PER CENT
		240	30♀		13.0
	18	100	840♂♀		97.7
		480	20♀		2.3
	25	0	40♀		80.0
		500	10♀		20.0
P-6805	2	0	550♀		57.9
		100	350	imm.	36.8
		250	40♂♀		4.2
		440	10♂♀		1.1
	3	250	60♀		66.7
		500	30♀		33.3
	4	0	350♂♀		58.3
		90	250♂♀		41.7
	5	0	1000♀		96.2
		250	40♀		3.8
	9	0	600♀		85.7
		65	100♀		14.3
	10	0	200♀		28.6
		55	500♀		71.4
	11	0	90♀		100.0
P-6811	1	0	100♀		17.9
		38	400♂♀		71.4
		250	60♂		10.7
	2	0	50♂♀	imm.	4.3
		77	1100♂♀	imm.	95.7
	3	63	1♂		100.0
	4	50	3500♂♀	imm.	100.0
	5	25	2100♀	imm.	95.5
		250	100♀		4.5
	6	25	850♂♀	imm.	100.0
	7	225	350	imm.	100.0
	8	27	50♀	imm.	100.0
	9	0	1000♀		95.2
		230	50♀		4.8
	10	0	1200♂♀	imm.	58.5
		25	850♂♀		41.5

TABLE 37 (continued)

Vertical distribution of <u>Euchaeta marina</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	11	0	200♀	100.0
	15	470	5♀	100.0
	17	485	20♀	100.0
	18	0	1650♂♀	100.0
	19	0	750♀	99.7
		75	2♀	0.3
	20	0	90 imm.	17.3
		75	400♂♀	76.9
		500	20♀	3.8
		750	10 imm.	1.9
P-6904	1	0	2300♂♀ imm.	92.0
		38	200♀	8.0
	2	14	1450♀ imm.	100.0
	3	265	180♂♀ imm.	100.0
	4	30	90 imm.	100.0
	5	500	20♂	100.0
	6	31	240♀ imm.	100.0
	7	0	150♂♀ imm.	9.6
		25	1400♂♀ imm.	89.2
		241	20 imm.	1.3
	9	0	40♂♀	33.3
		70	80♀	66.7
	10	30	60 imm.	85.7
		233	10♂	14.3
	11	0	2050♀	99.9
		262	2♂	0.1
	12	30	100 imm.	66.7
		515	10♂	6.7
		781	40♂♀ imm.	26.7
	13	0	50 imm.	22.9
		48	100♀ imm.	45.9
		258	60♀ imm.	27.5
		524	8♀	3.7
	14	458	10♀	66.7
		734	5 imm.	33.3
	18	261	120♀	24.9

TABLE 37 (continued)

Vertical distribution of Euchaeta marina

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER		PER CENT
		531	360♂♀		74.7
		1033	2♀		0.4
	19	550	130♂♀		100.0
	20	258	30♂♀		90.9
		537	3♀		9.1
	21	0	198♀		12.2
		50	1250♂♀	imm.	77.1
		220	150♂♀		9.3
		297	20♀		1.2
		490	3♀		0.2
P-6911	1	2337	1♀		100.0
	2	0	700♀		77.8
		53	200♀	imm.	22.2
	3	60	2300♀	imm.	97.4
		274	50♀		2.1
		739	12♀	imm.	0.5
	4	0	140♂♀		10.1
		81	1250♀		89.9
	5	59	570♀		100.0
	7	60	200♂♀	imm.	100.0
	8	60	1250 imm.		88.7
		243	60♀	imm.	4.3
		510	100♀		7.1
	9	0	2900♂♀	imm.	60.8
		60	1900♀	imm.	39.2
	10	0	1850♂♀	imm.	50.3
		56	1800♀	imm	49.0
		480	20 imm.		0.5
		975	2♀		0.1
		2118	2 imm.		0.1
		2660	1♀		0.0
	11	0	450♂♀		27.3
		58	1200♂♀		72.7
	12	78	1200♂♀	imm.	95.2
		465	60♀		4.8
	13	0	200♀		30.8
		65	450♂♀	imm.	69.2

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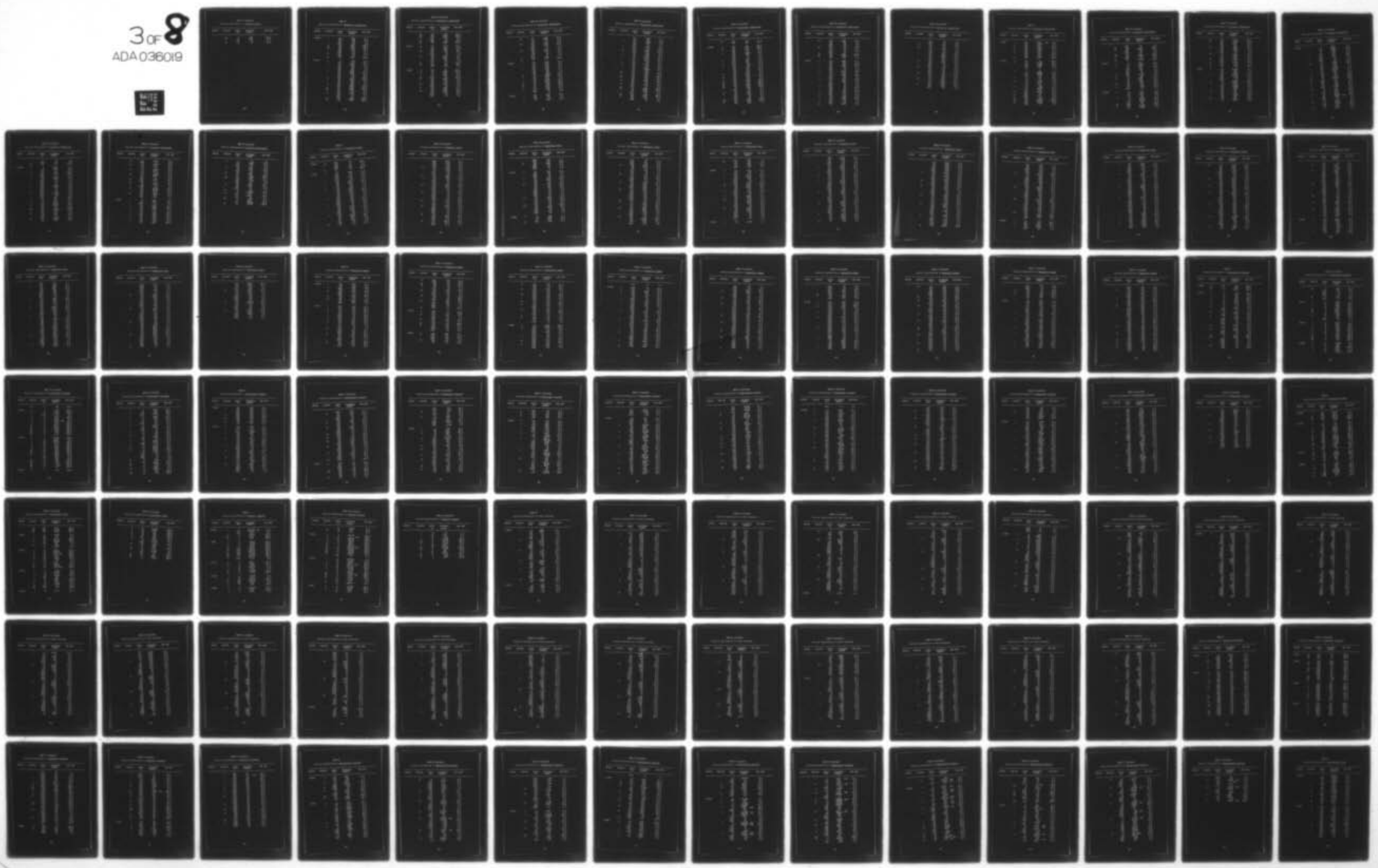

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TABLE 37 (continued)

Vertical distribution of Euchaeta marina

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	14	0	60♀	100.0
	15	53	400♀	98.8
		445	5♀	1.2
	16	478	3♀	100.0

TABLE 38

Vertical distribution of Haloptilus longicornis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6606	4	103	300♀	77.9
		285	50♀	13.0
		593	25♀	6.5
		1000	10♀	2.6
	8	100	400♀	100.0
	11	100	600♀	100.0
	12	100	150♀	84.7
		300	25♀	14.1
		1000	2♀	1.1
	13	100	75♀	93.7
		1000	5♀	6.2
	14	100	950♀	100.0
P-6701	1	0	10♀	12.5
		530	70♀	87.5
	2	90	1020♀	92.7
		220	10♀	0.9
		350	60♀	5.5
		500	10♀	0.9
	3	115	180♀	24.9
		250	120♀	16.6
		350	420♀	58.2
		435	2♀	0.3
	4	505	52♀	100.0
	5	90	900♀	90.9
		250	60♀	6.1
		504	30♀	3.0
	8	250	200♀	54.1
		505	170♀	45.9
	10	110	900♀	100.0
	11	110	400♀	99.0
		975	4♀	1.0
	12	100	800♀	99.4
		920	4♀	0.5
		1450	1♀	0.1
	13	100	600♀	100.0
	14	100	500♀	100.0

TABLE 38 (continued)

Vertical distribution of Haloptilus longicornis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	16	100	60♀	100.0
	18	100	1200♀	100.0
	20	250	450♀	99.8
		1050	1♀	0.2
	22	100	30♀	100.0
	24	100	300♀	100.0
P-6722	4	335	165♀	100.0
	9	155	40♀	14.8
		320	230♀	85.2
	10	405	30♀	88.2
		630	2♀	5.9
		1800	2♀	5.9
	12	80	800♀	83.5
		181	120♀	12.5
		310	36♀	3.8
		675	2♀	0.2
	15	132	6♀	100.0
	17	250	80♀	96.4
		525	3♀	3.6
P-6803	4	100	50♀	100.0
	5	40	200♀	100.0
	8	95	700♀	56.5
		175	540♀	43.5
	11	1030	6♀	100.0
	15	100	200♀	51.8
		200	180♀	46.6
		750	6♀	1.6
	16	100	220♀	99.1
		1000	2♀	0.9
	17	100	60♀	6.9
		240	810♀	93.1
	18	100	160♀	30.5
		245	360♀	68.6
		1500	1♀	0.2
		2150	4♀	0.8

TABLE 38 (continued)

Vertical distribution of Haloptilus longicornis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	20	125	200♀	66.0
		235	100♀	33.0
		740	3♀	1.0
	22	100	300♀	29.0
		200	720♀	69.6
		890	12♀	1.2
		1650	2♀	0.2
	25	250	640♀	96.0
		500	10♀	1.5
		750	4♀	0.6
		1000	3♀	0.4
		1425	10♀	1.5
	26	100	140♀	100.0
P-6805	2	100	450♀	70.3
		250	180♀	28.1
		715	10♀	1.6
	3	100	350♀	35.7
		250	540♀	55.1
		500	60♀	6.1
		1040	30♀	3.1
	4	90	250♂♀	100.0
	5	96	660♀	39.5
		250	800♀	47.9
		340	210♀	12.6
	7	50	2400♀	100.0
	9	250	390♀	100.0
	10	55	150♀	30.0
		245	350♀	70.0
	11	250	250♀	85.9
		537	40♀	13.7
		2550	1♀	0.3
P-6811	1	250	270♀	83.1
		500	40♀	12.3
		950	15♀	4.6
	2	77	350♀	47.9

TABLE 38 (continued)

Vertical distribution of Haloptilus longicornis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		237	350♀	47.9
		822	30♀	4.1
	3	225	180♂♀	92.8
		500	10♀	5.2
		1450	4♀	2.1
	4	270	160♀	91.4
		1050	15♀	8.6
	5	250	1250♀	100.0
	6	250	320♀	91.4
		485	30♀	8.6
	7	90	1200♀	41.5
		125	300♀	10.4
		225	1050♀	36.3
		275	320♀	11.1
		375	20♀	0.7
	8	238	1120♀	99.1
		480	10♀	0.9
	9	50	1300♀	64.4
		230	700♂♀	34.7
		635	20♀	1.0
	10	250	500♀	98.0
		750	10♀	2.0
	11	285	400♀	100.0
	12	160	80♀	36.4
		290	140♀	63.6
	14	285	140♀	96.6
		800	5♀	3.4
	15	237	120♀	98.4
		1325	2♀	1.6
	16	250	440♀	100.0
	17	85	1300♀	84.4
		237	240♀	15.6
		2375	1♀	0.1
	18	260	270♀	100.0
	19	320	960♀	99.2
		700	6♀	0.6
		800	2♀	0.2

TABLE 38 (continued)

Vertical distribution of <u>Haloptilus longicornis</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	20	250	12♀	37.5
		500	20♀	62.5
P-6904	1	415	10♀	100.0
	2	265	120♀	100.0
	3	265	150♀	98.7
		800	2♀	1.3
	4	230	500♂♀	90.6
		470	50♀	9.1
		950	1♀	0.2
		3560	1♀	0.2
	5	250	320♀	97.0
		1033	10♀	3.0
	6	232	50♀	96.2
		3144	2♂♀	3.8
	7	241	20♀	16.7
		452	40♀	33.3
		737	50♀	41.7
		918	10♀	8.3
	9	236	390♀	72.2
		467	150♀	27.8
	10	233	130♀	92.9
		455	10♀	7.1
	11	262	380♀	100.0
	12	259	230♀	100.0
	13	258	150♀	100.0
	14	239	360♀	100.0
	15	52	250♀	92.9
		261	18♀	6.7
		1500	1♀	0.4
	16	59	640♀	91.2
		253	60♀	8.5
		761	1♀	0.1
		1500	1♀	0.1
	17	251	260♀	100.0
	18	261	240♀	92.5
		531	20♀	7.7

TABLE 38 (continued)

Vertical distribution of Haloptilus longicornis

CRUISE	STATION	DEPTH (m)	ESTIAMTED NUMBER	PER CENT
	19	274	180♀	90.5
		550	10♀	5.0
		904	5♀	2.5
		1248	4♀	2.0
	20	258	55♀	80.9
		537	3♀	4.4
		827	9♀	13.2
		1588	1♀	1.5
	21	220	250♀	100.0
	22	252	570♀	91.9
		372	50♀	8.1
P-6911	1	250	100♀	66.7
		459	20♀	13.3
		911	30♀	20.0
	2	242	330♀	97.3
		844	7♀	2.1
		1272	2♀	0.6
	3	274	1050♀	98.3
		739	18♀	1.7
	4	218	220♀	90.9
		423	20♀	8.3
		1338	2♀	0.8
	5	237	700♀	96.8
		472	20♀	2.8
		698	1♀	0.1
		2474	2♀	0.3
	6	665	6♀	31.6
		888	4♀	21.1
		1324	9♀	47.4
	7	253	330♀	98.8
		1300	4♀	1.2
	8	243	60♀	75.0
		510	20♀	25.0
	9	250	250♀	95.1
		515	10♀	3.8
		1006	3♀	1.1
	10	227	640♀	99.5

TABLE 38 (continued)

Vertical distribution of Haloptilus longicornis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		975	2♀	0.3
		2660	1♀	0.2
	11	234	390♀	98.7
		491	5♀	1.3
	12	78	60♀	6.6
		153	20♀	2.2
		200	8♀	0.9
		258	63♀	6.9
		296	480♀	52.7
		344	180♀	19.8
		410	40♀	4.4
		465	60♀	6.6
	13	269	160♀	97.0
		500	4♀	2.4
		2232	1♀	0.6
	14	265	1♀	2.9
		785	25♀	73.5
		954	6♀	17.6
		1443	2♀	5.9
	15	224	90♀	44.8
		445	95♀	47.3
		970	16♀	8.0
	16	0	30♀	11.2
		243	220♀	82.1
		478	18♀	6.7
	17	261	210♀	87.9
		514	20♀	8.4
		1039	9♀	3.8

TABLE 39

Vertical distribution of Lucicutia flavicornis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER		PER CENT
P-6606	4	103	1200♀	imm.	96.0
		285	50♂♀		4.0
	11	100	250♀		83.3
		500	50♀		16.7
	12	100	900♂♀		97.3
		300	25♀		2.7
	13	100	175♀		66.0
		300	50♀		18.9
		500	40♀		15.1
	14	100	200♀		100.0
P-6701	1	530	5♀		100.0
	2	90	210♂♀		50.1
		220	125♂♀		29.8
		350	80♀		19.1
		500	4♀		1.0
	3	0	10♀		2.1
		115	190♂♀		39.4
		250	280♂♀		58.1
		435	2♀		0.4
	4	0	55♀		98.2
		130	1♀		1.8
	5	0	450♂♀		84.9
		90	50♀		9.4
		250	30♀		5.7
	8	70	2♂♀		0.6
		250	300♂♀		87.7
		505	40♀		11.7
	10	110	800♂♀		99.4
		1800	5♀		0.6
	11	500	20♀		95.2
		1800	1♀		4.8
	12	100	400♂♀		100.0
	13	100	950♂♀		100.0
	14	100	800♂♀		99.8
		1650	1♀		0.1

TABLE 39 (continued)

Vertical distribution of Lucicutia flavicornis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		4350	1♀	0.1
	16	398	3♂	100.0
	18	100	1900♂♀	99.9
		1000	1♂	0.1
		2200	1♀	0.1
	20	250	30♂	100.0
	22	100	210♂♀	99.5
		2000	1♀	0.5
	24	100	850♂♀	100.0
G-6722	4	0	250♀	62.5
		55	150♂♀	37.5
	9	0	350♀	90.4
		155	20♀	5.2
		320	15♀	3.9
		562	1♀	0.3
		1200	1♀	0.3
	10	225	150♂♀	94.3
		405	9♀	5.7
	12	0	200♀	62.5
		80	100♀	31.2
		181	20♀	6.2
	15	30	10♂	62.5
		132	6♀	37.5
	17	55	20♂♀	95.2
		2000	1♀	4.8
P-6803	4	0	40♀	20.0
		30	150♀	75.0
		100	10♀	5.0
	8	0	20♀	1.9
		40	650♂♀	60.2
		95	350♂♀	32.4
		175	60♀	5.6
	11	2500	4♀	100.0
	15	100	1400♂♀	92.1
		200	120♂♀	7.9

TABLE 39 (continued)

Vertical distribution of Lucicutia flavicornis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	16	100	440♂♀	100.0
	17	100	40♂♀	25.0
		240	100♀	62.5
		490	20♂	12.5
	18	100	40♀	16.5
		245	180♂♀	74.4
		480	20♂♀	8.3
		2150	2♀	0.8
	20	75	20♀	12.5
		125	120♂♀	75.0
		235	20♀	12.5
	22	100	800♂♀	99.5
		1650	4♀	0.5
	25	250	480♂♀	99.6
		1425	2♀	0.4
	26	100	80♂♀	100.0
P-6805	2	100	1650♂♀	95.4
		250	60♀	3.5
		715	20♂♀	1.2
	3	100	3250♂♀	85.7
		250	540♂♀	14.2
		2250	2♂♀	0.1
		2400	2♀	0.1
	4	90	1250♂♀	100.0
	5	0	300♀	37.5
		96	240♂♀	30.0
		250	200♂♀	25.0
		340	60♂♀	7.5
	7	50	300♀	98.4
		500	5♀	1.6
	9	65	50♀	20.8
		250	150♂♀	62.5
		500	40♀	16.7
	10	55	100♀	50.0
		245	100♂♀	50.0

TABLE 39 (continued)

Vertical distribution of <u>Lucicutia</u> <u>flavicornis</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER		PER CENT
P-6811	1	0	100♀		5.6
		38	1250♀		69.4
		250	450♂♀		25.0
	2	77	50♀		17.9
		237	150♀		53.6
		508	80♀		28.6
	3	225	570♀		99.5
		1450	2♂		0.3
		1800	1♀		0.2
	4	270	40♂♀		100.0
	6	25	750♂♀		88.2
		250	40♀		4.7
		485	60♂♀		7.1
	7	125	380♂♀		25.3
		225	1100♂♀		73.3
		275	20♀		1.3
	8	238	40♀		80.0
		480	10♀		20.0
	9	50	1100♂♀		100.0
	10	25	200♀		98.0
		1000	4♀		2.0
	12	160	70♀		46.7
		290	80♀		53.3
	15	237	600♂♀		99.7
		1325	2♀		0.3
	16	0	100♀		10.8
		52	750♀		80.6
		250	80♀		8.6
	17	85	450♀		26.9
		237	1200♂♀	imm.	71.8
		485	20♀		1.2
		1500	1♀		0.1
	18	0	100♀		8.3
		114	700♂♀		58.3
		260	360♀		30.0
		525	40♀		3.3
	19	0	1000♀		99.5

TABLE 39 (continued)

Vertical distribution of Lucicutia flavicornis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		75	3♀	0.3
		800	2♀	0.2
	20	250	16♀	100.0
P-6904	1	0	250♀	33.3
		38	500♀	66.6
		795	1♀	0.1
	2	265	20♀	100.0
	3	265	90♀	98.9
		3000	1♀	1.1
	4	230	625♂♀	95.7
		470	25♀	3.8
		1925	1♀	0.2
		3410	1♀	0.2
		3560	1♀	0.2
	5	250	480♂♀	98.6
		1033	5♀	1.0
		1534	1♀	0.2
		3655	1♀	0.2
	6	232	300♂♀	97.4
		1000	7♂♀	2.3
		3144	1♂	0.3
	7	241	80♀	88.9
		737	10♀	11.1
	9	70	20♀	5.3
		236	360♀	94.7
	10	233	160♂♀	94.1
		455	10♀	5.9
	11	262	3♀	100.0
	12	259	200♂♀	93.0
		781	15♀	7.0
	13	48	50♀	51.0
		258	40♀	40.8
		524	8♀	8.2
	14	239	660♂♀	98.5
		458	10♀	1.5

TABLE 39 (continued)

Vertical distribution of <u>Lucicutia</u> <u>flavicornis</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	15	261	120♂♀	99.2
		1500	1♀	0.8
	16	59	760♂♀	84.4
		253	140♀	15.5
		519	1♀	0.1
	17	45	360♂♀	55.0
		251	280♀	42.7
		750	15♂♀	2.3
	18	62	260♂♀	51.8
		261	240♀	47.8
		1532	2♀	0.4
	19	274	360♀	99.7
		1583	1♀	0.3
	20	10	850♀	98.5
		258	12♂♀	1.4
		1588	1♂	0.1
	21	50	300♂♀	46.9
		220	300♂♀	46.9
		297	40♀	6.2
	22	252	390♂♀	90.7
		372	10♀	2.3
		450	30♀	7.0
P-6911	1	65	300♀	42.8
		250	400♀	57.1
		1835	1♀	0.1
	2	53	100♀	35.7
		242	180♀	64.3
	3	274	100♀	94.3
		739	6♀	5.7
	4	81	100♀	83.3
		218	20♂	16.7
	5	237	100♀	83.3
		472	20♀	16.7
	6	50	50♀	55.6
		481	40♀	44.4
	7	253	180♀	100.0

TABLE 39 (continued)

Vertical distribution of Lucicutia flavicornis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	8	0	1♀	0.4
		243	210♂♀	83.0
		510	40♀	15.8
		1548	2♀	0.8
	9	60	100♀	28.3
		250	250♀	70.8
		1006	3♀	0.8
	10	56	100♀	71.4
		227	40♀	28.6
	11	234	210♂♀	100.0
	12	153	20♀	22.7
		200	22♂♀	25.0
		258	6♀	6.8
		296	40♀	45.5
	13	65	100♀	90.1
		269	10♀	9.0
		2232	1♀	0.9
	14	0	30♂	1.1
		34	2650♂♀	98.9
	15	53	40♀	3.2
		224	1200♀	96.4
		445	5♀	0.4
	16	0	30♀	3.4
		51	640♀	73.6
		243	200♂♀	23.0
	17	54	750♂♀	100.0

TABLE 40

Vertical distribution of Mormonilla minor

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6606	8	3250	3♀	100.0
	12	500	2♀	6.1
		1000	1♀	3.0
		1500	30♀	90.9
	13	1300	1♀	100.0
P-6701	1	530	220♀	55.8
		845	62♀	15.7
		1250	2♀	0.5
		1725	105♀	26.6
		2425	5♀	1.3
	2	220	155♀	12.5
		350	1020♀	82.3
		500	36♀	2.9
		575	29♀	2.3
	3	115	60♀	2.7
		250	1230♀	56.0
		350	550♀	25.0
		435	206♀	9.4
		750	93♀	4.2
		970	58♀	2.6
	4	505	40♀	41.2
		1000	22♀	22.7
		1338	28♀	28.9
		2500	6♀	6.2
		3500	1♀	1.0
	5	250	970♀	78.1
		504	140♀	11.3
		860	102♀	8.2
		1000	28♀	2.3
		1830	2♀	0.2
	8	250	2500♀	68.1
		505	890♀	24.2
		817	200♀	5.4
		955	65♀	1.8
		1625	17♀	0.5
	10	500	44♀	10.7

TABLE 40 (continued)

Vertical distribution of <u>Mormonilla</u> <u>minor</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1000	125♀	30.3
		1800	155♀	37.5
		2200	26♀	6.3
		2850	63♀	15.3
	11	500	670♀	75.4
		975	144♀	16.2
		1525	15♀	1.7
		1800	9♀	1.0
		2375	51♀	5.7
	12	500	290♀	72.5
		920	60♀	15.0
		1450	35♀	8.7
		1825	3♀	0.7
		2450	12♀	3.0
	13	450	780♀	72.0
		1000	265♀	24.4
		1500	37♀	3.4
		3200	2♀	0.2
	14	500	4♀	36.4
		1000	1♀	9.1
		1650	1♀	9.1
		2150	4♀	36.4
		4350	1♀	9.1
	16	398	60♀	58.8
		775	38♀	37.3
		1250	4♀	3.9
	18	500	580♀	97.8
		1625	9♀	1.5
		2200	2♀	0.3
		2650	1♀	0.2
		3800	1♀	0.2
	20	100	2♀	0.5
		250	390♀	92.6
		1050	18♀	4.3
		1500	11♀	2.6
	22	475	1080♀	85.2
		1000	140♀	11.0
		1650	18♀	1.4

TABLE 40 (continued)

Vertical distribution of Mormonilla minor

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		2000	22♀	1.7
		2350	8♀	0.6
	24	500	360♀	92.8
		1000	25♀	6.4
		2600	2♀	0.5
		3000	1♀	0.3
G-6722	4	335	80♀	87.9
		581	3♀	3.3
		1040	2♀	2.2
		1520	6♀	6.6
	9	155	270♀	26.8
		320	735♀	73.1
		562	1♀	0.1
	10	225	80♀	39.4
		405	72♀	35.5
		630	20♀	14.8
		824	4♀	2.0
		1800	3♀	1.5
		3000	11♀	5.4
		3500	2♀	1.0
		4500	1♀	0.5
	12	181	490♀	78.7
		310	70♀	11.2
		675	62♀	10.0
		1150	1♀	0.2
	15	450	8♀	100.0
	17	250	350♀	83.7
		525	36♀	8.6
		1000	6♀	1.4
		1500	20♀	4.8
		2000	6♀	1.4
P-6803	8	40	50♀	4.1
		95	200♀	16.5
		175	960♀	79.3
	11	580	150♀	61.7

TABLE 40 (continued)

Vertical distribution of Mormonilla minor

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1030	42♀	17.3
		1500	28♀	11.5
		2000	23♀	9.5
	15	200	1820♀	85.8
		400	210♀	9.9
		750	40♀	1.9
		995	47♀	2.2
		1200	3♀	0.1
	16	225	7♀	4.0
		420	84♀	47.7
		1000	67♀	38.1
		1500	14♀	8.0
		3000	4♀	2.3
	17	240	460♀	36.1
		490	600♀	47.1
		1000	105♀	8.2
		2200	109♀	8.6
	18	245	580♀	65.9
		480	70♀	8.0
		1000	111♀	12.6
		1500	73♀	8.3
		2150	20♀	2.3
		2200	19♀	2.2
		3500	7♀	0.8
	20	75	20♀	1.6
		235	650♀	53.1
		475	430♀	35.2
		740	123♀	10.1
	22	200	210♀	16.9
		470	880♀	70.7
		890	82♀	6.6
		1650	51♀	4.1
		3000	21♀	1.7
	25	100	5♀	0.2
		250	1920♀	80.1
		500	270♀	11.3
		750	54♀	2.3
		1000	111♀	4.6

TABLE 40 (continued)

Vertical distribution of *Mormonilla minor*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1425	38♀	1.6
	26	150	19♀	2.4
		480	720♀	92.3
		750	26♀	3.3
		1000	15♀	1.9
P-6805	2	250	440♀	93.6
		440	5♀	1.1
		1500	25♀	5.3
	3	250	1620♀	61.4
		500	840♀	31.8
		1040	30♀	1.1
		2250	5♀	0.2
		2400	144♀	5.5
	4	3350	100♀	100.0
	5	250	4040♀	76.5
		340	1230♀	23.3
		500	8♀	0.2
	7	1000	170♀	81.3
		2300	36♀	17.2
		2650	3♀	1.4
	9	250	1890♀	77.1
		500	560♀	22.9
	10	245	50♀	4.2
		477	840♀	70.9
		995	290♀	24.5
		1500	2♀	0.2
		2256	2♀	0.2
	11	250	1250♀	76.5
		537	160♀	9.8
		1050	200♀	12.2
		1700	6♀	0.4
		2263	7♀	0.4
		2550	2♀	0.1
		4517	9♀	0.6
P-6811	1	250	1710♀	51.7

TABLE 40 (continued)

Vertical distribution of Mormonilla minor

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		500	1420♀	42.9
		750	145♀	4.4
		950	15♀	0.5
		1380	6♀	0.2
		2025	13♀	0.4
	2	237	1850♀	78.2
		508	360♀	15.2
		822	130♀	5.5
		1000	24♀	1.0
		1200	1♀	0.0
	3	500	70♀	43.2
		770	84♀	51.9
		1450	8♀	4.9
	4	270	740♀	37.4
		550	1000♀	50.5
		1050	115♀	5.8
		1800	51♀	2.6
		2312	15♀	0.8
		3000	20♀	1.0
		3250	38♀	1.9
	5	250	850♀	82.4
		500	160♀	15.5
		750	2♀	0.2
		1823	13♀	1.3
		2450	3♀	0.3
		2850	3♀	0.3
	6	250	1960♀	57.5
		485	930♀	27.3
		720	390♀	11.4
		1000	4♀	0.1
		1750	16♀	0.5
		2025	105♀	3.1
		2525	3♀	0.1
	7	225	500♀	14.9
		275	960♀	28.7
		375	1300♀	38.8
		500	590♀	17.6
	8	27	10♀	0.4

TABLE 40 (continued)

Vertical distributionof <u>Mormonilla minor</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		238	1540♀	54.0
		480	80♀	2.8
		713	824♀	28.9
		1000	165♀	5.8
		1500	180♀	6.3
		2000	52♀	1.8
	9	230	1600♀	54.6
		450	40♀	1.4
		635	1020♀	34.8
		1400	10♀	0.3
		1525	260♀	8.9
	10	500	150♀	57.0
		900	29♀	11.0
		1000	84♀	31.9
	11	285	575♀	47.9
		590	525♀	43.7
		800	20♀	1.7
		1200	5♀	0.4
		1400	76♀	6.3
	12	160	430♀	46.3
		290	270♀	29.1
		550	24♀	2.6
		775	196♀	21.1
		1100	8♀	0.9
	14	285	1760♀	69.3
		590	540♀	21.3
		800	105♀	4.1
		1175	1♀	0.0
		1700	126♀	5.0
		1875	5♀	0.2
		2375	1♀	0.0
	15	237	810♀	74.2
		470	5♀	0.5
		1000	26♀	2.4
		1325	82♀	7.5
		1500	29♀	2.7
		1950	140♀	12.8
	16	250	5780♀	94.9

TABLE 40 (continued)

Vertical distribution of Mormonilla minor

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		500	46♀	0.8
		750	95♀	1.6
		1000	24♀	0.4
		1500	112♀	1.8
		2150	33♀	0.5
	17	237	4770♀	80.3
		485	660♀	11.1
		714	12♀	0.2
		1000	350♀	5.9
		1500	81♀	1.4
		1950	30♀	0.5
		2375	33♀	0.6
		3500	5♀	0.1
	18	260	2070♀	71.4
		525	500♀	17.2
		763	192♀	6.6
		1050	74♀	2.6
		1500	14♀	0.5
		2500	46♀	1.6
		3500	3♀	0.1
	19	320	1710♀	82.1
		700	210♀	10.1
		800	60♀	2.9
		1250	18♀	0.9
		1500	1♀	0.0
		1625	40♀	1.9
		1850	20♀	1.0
		2350	25♀	1.2
	20	250	4♀	0.4
		500	660♀	60.6
		750	420♀	38.5
		1000	6♀	0.6
P-6904	1	415	90♀	60.0
		1450	60♀	40.0
	2	265	1420♀	91.6
		500	110♀	7.1
		1150	20♀	1.3

TABLE 40 (continued)

Vertical distribution of Mormonilla minor

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	3	265	510♀	77.2
		550	120♀	18.2
		800	2♀	0.3
		1700	24♀	3.6
		2000	2♀	0.3
		2250	3♀	0.5
	4	230	475♀	49.7
		470	425♀	44.5
		950	6♀	0.6
		1925	33♀	3.5
		2380	2♀	0.2
		3410	1♀	0.1
		3560	13♀	1.4
	5	250	840♀	78.9
		500	200♀	18.8
		1033	10♀	0.9
		2000	3♀	0.3
		2620	3♀	0.3
		3655	1♀	0.1
		4105	7♀	0.7
	6	232	2200♀	97.9
		418	1♀	0.0
		1000	8♀	0.4
		1500	16♀	0.7
		2042	12♀	1.5
		2575	3♀	0.1
		3144	5♀	0.2
		3594	2♀	0.1
		5000	1♀	0.0
	7	241	420♀	51.5
		452	160♀	19.6
		737	90♀	11.0
		918	80♀	9.8
		1404	66♀	8.1
	9	236	2370♀	68.6
		467	750♀	21.7
		676	320♀	9.3
		1000	16♀	0.5

TABLE 40 (continued)

Vertical distribution of Mormonilla minor

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	10	233	750♀	48.0
		455	340♀	21.8
		663	170♀	10.9
		981	48♀	3.1
		1484	150♀	9.6
		1665	2♀	0.1
		1892	71♀	4.5
		2394	32♀	2.0
	11	262	860♀	70.5
		524	190♀	15.6
		759	110♀	9.0
		1036	60♀	4.9
	12	259	330♀	56.4
		515	140♀	23.9
		781	70♀	12.0
		1036	45♀	7.7
	13	258	880♀	52.3
		524	672♀	39.9
		753	60♀	3.6
		1019	14♀	0.8
		1638	33♀	2.0
		2115	7♀	0.4
		2612	17♀	1.0
	14	239	60♀	30.9
		458	40♀	20.6
		734	40♀	20.6
		1052	16♀	8.2
		1454	24♀	12.4
		1828	11♀	5.7
		2336	3♀	1.5
	15	261	432♂♀	30.7
		524	900♀	64.1
		791	36♀	2.6
		1057	8♀	0.6
		1816	5♀	0.4
		2248	24♀	1.7
	16	59	40♀	2.1
		253	1860♀	97.7

TABLE 40 (continued)

Vertical distribution of Mormonilla minor

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		974	3♀	0.2
	17	251	2160♀	90.4
		750	95♀	4.0
		971	135♂♀	5.6
	18	261	2160♀	61.1
		531	1020♀	28.8
		802	80♀	2.3
		1033	26♀	0.7
		1532	15♀	0.4
		1747	40♀	1.1
		1942	48♀	1.4
		2540	148♂♀	4.2
	19	274	500♀	78.2
		550	80♀	12.5
		904	39♀	6.1
		1248	9♀	1.4
		1583	3♀	0.5
		1986	1♀	0.2
		2524	7♀	1.1
	20	258	75♀	41.9
		537	78♀	43.6
		827	24♀	13.4
		1588	2♀	1.1
	21	220	800♀	83.4
		297	140♀	14.6
		431	10♀	1.0
		490	9♀	0.9
	22	252	1320♀	64.4
		372	350♀	17.1
		450	120♀	5.9
		554	100♀	4.9
		620	160♀	7.8
P-6911	1	250	5400♀	85.3
		459	600♀	9.5
		715	96♀	1.5
		911	141♀	2.2
		1371	50♂♀	0.8
		1835	24♀	0.4
		2337	23♀	0.4
	2	242	570♀	60.1
		533	340♀	35.8

TABLE 40 (continued)

Vertical distribution of <u>Mormonilla</u> <u>minor</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		844	23♀	2.4
		1272	16♀	1.7
	3	274	850♀	60.3
		494	350♀	24.8
		739	96♀	6.8
		1040	50♀	3.5
		1567	25♀	1.8
		2072	38♀	2.7
		2556	1♀	0.1
	4	218	720♀	56.2
		423	460♀	35.9
		836	90♀	7.0
		1338	10♀	0.8
		1844	1♀	0.1
	5	237	1000♀	55.0
		472	480♀	26.4
		698	152♀	8.4
		996	140♀	7.7
		1878	24♀	1.3
		2474	22♀	1.2
	6	240	1♀	0.3
		481	160♀	55.0
		665	42♀	14.4
		888	64♀	22.0
		1324	24♀	8.2
	7	253	210♀	19.8
		539	220♀	20.8
		779	500♀	47.2
		1000	28♀	2.6
		1300	102♀	9.6
	8	243	840♀	49.5
		510	520♀	30.7
		995	22♀	1.3
		1548	132♀	7.8
		2088	72♀	4.2
		2316	110♀	6.5
	9	250	950♀	73.3
		515	90♀	6.9

TABLE 40 (continued)

Vertical distribution of Mormonilla minor

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1006	111♀	8.6
		1580	63♀	4.9
		2088	6♀	0.5
		2454	46♀	3.5
		3442	27♀	2.1
		3910	3♀	0.2
	10	227	3280♀	75.0
		480	820♀	18.8
		975	30♀	0.7
		1500	58♀	1.3
		2032	1♀	0.0
		2118	94♀	2.2
		2660	83♀	1.9
		3176	5♀	0.1
	11	234	990♀	74.1
		491	120♀	9.0
		969	42♀	3.1
		1570	34♀	2.5
		2104	46♀	3.4
		2490	67♀	5.0
		3602	35♀	2.6
		4096	2♀	0.1
	12	153	60♀	2.4
		200	44♀	1.8
		258	189♀	7.7
		296	800♀	32.6
		344	380♀	15.5
		410	320♀	13.0
		465	660♀	26.9
	13	269	940♀	70.0
		500	260♀	19.4
		1036	12♀	0.9
		1601	76♀	5.7
		2232	12♀	0.9
		2862	38♀	2.8
		5200	4♀	0.3
	14	265	2♀	0.1

TABLE 40 (continued)

Vertical distribution of Mormonilla minor

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		520	2300♀	80.2
		785	320♀	11.2
		954	176♀	6.1
		1443	69♀	2.4
	15	224	2370♀	84.2
		445	95♀	3.4
		970	260♀	9.2
		1424	31♀	1.1
		1998	16♀	0.6
		2950	19♀	0.7
		3932	24♀	0.9
	16	243	6680♂♀	98.5
		478	24♀	0.4
		1012	1♀	0.0
		1525	32♀	0.5
		2032	44♀	0.6
	17	261	3540♀	89.4
		514	160♀	4.0
		1039	228♀	5.8
		1590	4♀	0.1
		2216	27♀	0.7

TABLE 41

Vertical distribution of Mormonilla phasma

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6606	4	285	100♀	90.9
		700	10♀	9.1
	8	1000	100♀	90.9
		2000	10♀	9.1
	11	500	200♀	80.0
		1000	5♀	2.0
		2000	45♀	18.0
	12	300	350♀	98.3
		500	6♀	1.7
	13	300	275♀	49.5
		500	260♀	46.8
		1000	20♀	3.6
P-6701	1	845	18♀	64.3
		1725	10♀	35.7
	2	575	2♀	100.0
	3	750	11♀	64.7
		970	6♀	35.3
	4	1000	9♀	69.2
		1338	4♀	30.8
	5	860	24♀	68.6
		1000	11♀	31.4
	8	505	60♀	50.0
		817	50♀	41.7
		955	7♀	5.8
		1625	3♀	2.5
	10	500	1♀	2.7
		1800	30♀	81.1
		2850	6♀	16.2
	11	500	20♀	29.4
		975	20♀	29.4
		1525	8♀	11.8
		1800	5♀	7.4
		2375	15♀	22.1
	12	500	30♀	60.0
		920	14♀	28.0
		1450	6♀	12.0

TABLE 41 (continued)

Vertical distribution of *Mormonilla phasma*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	13	1000	50♀	82.0
		1500	11♀	18.0
	14	500	2♀	100.0
	16	398	9♀	64.3
		775	1♀	7.1
		1250	4♀	28.6
	18	500	120♀	94.5
		1625	6♀	4.7
		2650	1♀	0.8
	20	100	1♀	10.0
		450	1♀	10.0
		1050	8♀	80.0
	22	475	90♀	78.3
		1000	20♀	17.4
		1650	3♀	2.6
		2000	2♀	1.7
	24	1000	2♀	100.0
G-6722	4	581	1♀	50.0
		1520	1♀	50.0
	10	630	66♀	95.7
		824	2♀	2.9
		1800	1♀	1.4
	12	675	14♀	93.3
		1150	1♀	6.7
	15	450	2♀	100.0
	17	250	10♀	55.6
		1000	2♀	11.1
		1500	4♀	22.2
		2000	2♀	11.1
P-6803	11	580	60♀	62.5
		1030	9♀	9.4
		1500	20♀	20.8
		2000	7♀	7.3
	15	750	15♀	75.0
		995	5♀	25.0

TABLE 41 (continued)

Vertical distribution of Mormonilla phasma

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	16	420	12♀	41.4
		1000	14♀	48.3
		1500	3♀	10.3
	17	490	340♀	94.4
		1000	12♀	3.3
		2200	8♀	2.2
	18	480	40♀	40.8
		1000	27♀	27.6
		1500	28♀	28.6
		2200	3♀	3.1
	20	475	60♀	51.3
		740	57♀	48.7
	22	890	20♀	50.0
		1650	17♀	42.5
		3000	3♀	7.5
	25	500	50♀	56.2
		750	16♀	18.0
		1000	21♀	23.6
		1425	2♀	2.2
	26	150	2♀	3.0
		480	60♀	89.6
		750	2♀	3.0
		1000	3♀	4.5
P-6805	2	715	360♀	100.0
	3	500	1400♀	100.0
	4	1010	70♀	15.6
		1500	37♀	8.3
		2000	340♀	75.9
		2323	1♀	0.2
	9	500	40♀	27.4
		1438	9♀	6.2
		2026	97♀	66.4
	10	1500	11♀	40.7
		2256	16♀	59.3
	11	1050	10♀	3.7
		1700	252♀	93.7
		2263	5♀	1.9

TABLE 41 (continued)

Vertical distribution of <u>Mormonilla</u> <u>phasma</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		2550	2♀	0.7
P-6811	1	1380	4♀	36.4
		2025	7♀	63.6
	2	822	280♀	75.3
		1000	92♀	24.7
	3	500	10♀	26.3
		770	20♀	52.6
		1450	4♀	10.5
		1800	4♀	10.5
	4	550	40♀	31.5
		1050	50♀	39.4
		1800	23♀	18.1
		2312	5♀	3.9
		3000	2♀	1.6
		3250	7♀	5.5
	5	500	280♀	88.6
		750	4♀	1.3
		1823	24♀	7.6
		2450	5♀	1.6
		2850	3♀	0.9
	6	720	250♀	90.9
		1000	1♀	0.4
		1750	13♀	4.7
		2025	9♀	3.3
		2525	2♀	0.7
	7	375	80♀	61.5
		500	50♀	38.5
	8	480	10♀	5.0
		713	72♀	36.0
		1000	70♀	35.0
		1500	36♀	18.0
		2000	12♀	6.0
	9	635	360♀	78.6
		1400	3♀	0.7
		1525	95♀	20.7
	10	500	120♀	46.9

TABLE 41 (continued)

Vertical distribution of Mormonilla phasma

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		750	1♀	0.4
		900	3♀	1.2
		1000	132♀	51.6
	11	590	400♀	84.2
		800	20♀	4.2
		1200	3♀	0.6
		1400	52♀	10.9
	12	550	9♀	8.0
		775	92♀	81.4
		1100	12♀	10.6
	14	590	30♀	38.0
		800	5♀	6.3
		1175	1♀	1.3
		1700	24♀	30.4
		1875	7♀	8.9
		2375	2♀	2.5
		2850	10♀	12.7
	15	1000	20♀	19.4
		1325	30♀	29.1
		1500	7♀	6.8
		1950	46♀	44.7
	16	500	4♀	7.4
		750	10♀	18.5
		1000	4♀	7.4
		1500	28♀	51.9
		2150	8♀	14.8
	17	1000	30♀	33.3
		1500	45♀	50.0
		1950	5♀	5.6
		2375	10♀	11.1
	18	525	100♀	73.5
		763	16♀	11.8
		1050	4♀	2.9
		1500	10♀	7.4
		2500	5♀	3.7
		3500	1♀	0.7
	19	800	4♀	9.5

TABLE 41 (continued)

Vertical distribution of <u>Mormonilla</u> <u>phasma</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1250	8♀	19.0
		1500	2♀	4.8
		1625	16♀	38.1
		1850	10♀	23.8
		2350	2♀	4.8
	20	500	20♀	19.6
		750	80♀	78.4
		1000	2♀	2.0
P-6904	1	415	50♀	55.6
		1450	40♀	44.4
	2	1150	10♀	100.0
	3	550	120♀	96.0
		1700	4♀	3.2
		2250	1♀	0.8
	4	950	4♀	23.5
		1925	6♀	35.3
		3560	7♀	41.2
	5	1033	105♀	62.1
		1534	1♀	0.6
		2000	21♀	12.4
		2620	17♀	10.1
		3655	4♀	2.4
		4105	21♀	12.4
	6	1000	3♀	3.2
		1500	56♀	59.6
		2042	24♀	25.5
		2575	3♀	3.2
		3144	5♀	5.3
		3594	2♀	2.1
		4000	1♀	1.1
	7	241	20♀	4.4
		737	310♀	68.0
		918	80♀	17.5
		1404	46♀	10.1
	9	676	40♀	66.7
		1000	20♀	33.3

TABLE 41 (continued)

Vertical distribution of Mormonilla phasma

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	10	455	10♀	6.8
		663	60♀	40.8
		981	32♀	21.8
		1484	10♀	6.8
		1892	23♀	15.6
		2394	12♀	8.2
	11	759	50♀	86.2
		1036	8♀	13.8
	12	515	130♀	87.2
		781	10♀	6.7
		1036	9♀	6.0
	13	524	168♀	67.5
		753	42♀	16.9
		1019	6♀	2.4
		1638	30♀	12.0
		2115	3♀	1.2
	14	734	15♀	50.0
		1052	2♀	6.7
		1454	10♀	33.3
		1828	3♀	10.0
	15	524	740♀	97.8
		791	12♀	1.6
		1057	2♀	0.3
		2248	3♀	0.4
	16	974	6♀	100.0
	17	750	95♀	31.7
		971	187♀	62.3
		1408	18♀	6.0
	18	1033	12♀	25.0
		1532	1♀	2.1
		1747	11♀	22.9
		1942	8♀	16.7
		2540	16♀	33.3
	19	904	7♀	41.2
		1248	6♀	35.3
		1583	1♀	5.9
		2524	3♀	17.6
	20	537	3♀	3.0

TABLE 41 (continued)

Vertical distribution of Mormonilla phasma

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		827	93♀	93.9
		1052	1♀	1.0
		1588	2♀	2.0
	21	431	2♀	40.0
		490	3♀	60.0
	22	450	90♀	60.0
		554	40♀	26.7
		620	20♀	13.3
P-6911	1	250	150♀	51.5
		459	20♀	6.9
		715	27♀	9.3
		911	75♀	25.8
		1371	6♀	2.1
		1835	10♀	3.4
		2337	3♀	1.0
	2	242	30♀	18.4
		533	120♀	73.6
		844	9♀	5.5
		1272	4♀	2.5
	3	739	132♀	61.1
		1040	55♀	25.5
		2072	28♀	13.0
		2556	1♀	0.5
	4	423	120♀	72.7
		836	30♀	18.2
		1338	14♀	8.5
		1844	1♀	0.6
	5	472	180♀	52.2
		698	112♀	32.5
		996	25♀	7.2
		1878	26♀	7.5
		2474	2♀	0.6
	6	665	12♀	33.3
		888	12♀	33.3
		1324	12♀	33.3
	7	779	130♀	77.4

TABLE 41 (continued)

Vertical distribution of *Mormonilla phasma*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1000	6 ♀	3.6
		1300	32 ♀	19.0
	8	510	40 ♀	47.6
		995	2 ♀	2.4
		1548	26 ♀	31.0
		2088	4 ♀	4.8
		2316	12 ♀	14.3
	9	515	20 ♀	31.2
		1006	21 ♀	32.8
		1580	21 ♀	32.8
		2454	2 ♀	3.1
	10	480	140 ♀	59.6
		975	10 ♀	4.3
		1500	38 ♀	16.2
		2032	3 ♀	1.3
		2118	30 ♀	12.8
		2660	12 ♀	5.1
		3176	2 ♀	0.8
	11	491	5 ♀	14.3
		969	9 ♀	25.7
		1570	10 ♀	28.6
		2104	7 ♀	20.0
		2490	4 ♀	11.4
	13	500	20 ♀	44.4
		1036	8 ♀	17.8
		1601	16 ♀	35.6
		2232	1 ♀	2.2
	14	520	22 ♀	21.8
		785	40 ♀	39.6
		954	34 ♀	33.7
		1443	5 ♀	5.0
	15	970	136 ♀	97.8
		1424	3 ♀	2.2
	16	1525	3 ♀	50.0
		2032	3 ♀	50.0
	17	1039	6 ♀	60.0
		1590	2 ♀	20.0
		2216	2 ♀	20.0

TABLE 42

Vertical distribution of <u>Paracalanus aculeatus</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6606	11	1000	10♀	100.0
	13	0	300♀	100.0
	14	10	1200♀	100.0
P-6701	1	0	10♀	100.0
	2	0	10♀	25.0
		90	30♀	75.0
	3	0	20♀	100.0
	5	0	400♀	88.9
		90	50♀	11.1
	8	0	950♀	99.6
		70	4♀	0.4
	10	0	15♀	6.8
		110	200♀	91.3
		2200	4♀	1.8
	11	0	10♀	3.2
		110	3000♀	96.2
		1800	2♀	0.6
	12	0	110♀	16.6
		100	550♀	83.0
		1825	1♀	0.2
		2450	1♀	0.2
		3200	1♀	0.2
	13	0	1950♀	99.7
		1000	5♀	0.3
	14	0	6050♀	95.9
		100	250♀	4.0
		1650	3♀	0.0
		2150	3♀	0.0
	16	0	240♀	100.0
	18	0	900♀	98.7
		1000	5♀	0.5
		2200	4♀	0.4
		2650	2♀	0.2
		4350	1♀	0.1
	20	850	3♀	60.0
		1500	2♀	40.0

TABLE 42 (continued)

Vertical distribution of <u>Paracalanus aculeatus</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	22	0	60♀	62.5
		100	30♀	31.2
		1650	1♀	1.0
		2000	3♀	3.1
		2350	2♀	2.1
	24	0	250♀	99.2
		3000	2♀	0.8
G-6722	4	0	500♀	66.7
		55	250♀	33.3
	9	0	200♀	66.7
		40	100♀	33.3
	10	0	450♀	100.0
	12	0	6300♀	100.0
	15	0	200♀	80.0
		30	50♀	20.0
	17	0	560♀	93.2
		55	40♀	6.7
		2000	1♀	0.2
P-6803	4	0	100♀	13.3
		30	650♀	86.7
	5	0	450♀	90.0
		40	50♀	10.0
	8	0	180♀	100.0
	11	0	80♀	61.5
		30	50♀	38.5
	15	0	220♀	100.0
	17	0	400♀	100.0
	18	0	90♀	100.0
	20	75	20♀	100.0
P-6805	2	0	850♂♀	98.8
		715	10♀	1.2
	3	0	100♀	100.0
	4	0	2750♀	96.5
		90	100♀	3.5
	7	0	150♂♀	100.0

TABLE 42 (continued)

Vertical distribution of <u>Paracalanus aculeatus</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	10	0	50♀	100.0
P-6811	1	0	350♀	100.0
	2	0	80♀	100.0
	3	0	1500♀	99.9
		1450	2♀	0.1
	4	0	1650♀	100.0
	5	0	400♀	66.7
		25	200♀ imm.	33.3
	6	0	100♀	100.0
	7	0	120♀	100.0
	11	0	1650♀	100.0
	12	35	150♀	100.0
	14	0	1150♀	100.0
	18	0	200♀	100.0
	19	75	18♀	100.0
	20	75	150♀	100.0
P-6904	1	0	3350♀	100.0
	2	0	1950♀	52.0
		14	1800♀	48.0
	3	30	1350♀	100.0
	4	30	150♀	100.0
	5	21	300♀	100.0
	6	0	350♀	100.0
	9	70	140♀	100.0
	10	233	60♀	100.0
	11	45	100♀	100.0
	12	0	390♀	76.5
		30	100♀	19.6
		515	20♀	3.9
	13	0	100♀	100.0
	14	0	5♀	100.0
	15	52	250♀	100.0
	16	0	4♂♀	100.0
	18	62	20♀	100.0
P-6911	1	0	90♀	100.0

TABLE 42 (continued)

Vertical distribution of Paracalanus aculeatus

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	2	0	200 ♀	80.0
		53	50 ♀	20.0
	3	60	1050 ♀	99.9
		2072	1 ♀	0.1
	4	0	180 ♀	64.3
		81	100 ♀	35.7
	5	0	5 ♀	13.5
		59	30 ♀	81.1
		1878	2 ♀	5.4
	6	0	160 ♀	5.3
		50	2850 ♀	94.6
		240	2 ♀	0.1
		665	2 ♀	0.1
	7	0	8 ♀	16.7
		60	40 ♀	83.3
	8	0	10 ♀	2.2
		60	450 ♀	97.6
		995	1 ♀	0.2
	9	0	1250 ♀	43.8
		60	1600 ♀	56.1
		2088	2 ♀	0.1
	10	0	1800 ♀	59.0
		56	1250 ♀	41.0
	11	0	2250 ♀	50.1
		58	2200 ♀	49.0
		234	30 ♀	0.7
		969	3 ♀	0.1
		2104	4 ♀	0.1
		2490	1 ♀	0.0
	12	0	18 ♀	7.0
		36	240 ♀	93.0
	13	65	1800 ♀	100.0
	14	0	30 ♀	9.1
		34	300 ♀	90.9
	15	0	2100 ♀	77.8
		53	600 ♀	22.2
	16	0	30 ♀	100.0
	17	54	50 ♀	100.0

TABLE 43

Vertical distribution of Rhincalanus cornutus

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6606	4	285	25♀	19.2
		593	75♀	57.7
		700	20♀	15.4
		1000	10♀	7.7
	8	500	50♀	50.0
		1000	50♀	50.0
	12	300	25♀	96.2
		500	1♀	3.8
	13	300	275♀	87.3
		500	40♀	12.7
P-6701	1	530	35♀	22.2
		845	8♀	5.1
		1725	105♀	66.5
		2425	10♂♀	6.3
	2	350	80♀	92.0
		500	6♀	6.9
		575	1♀	1.1
	3	350	50♀	49.5
		435	14♂♀	13.9
		750	11♀	10.9
		970	26♀	25.7
	4	505	12♀	85.7
		1338	1♀	7.1
		2500	1♀	7.1
	5	250	60♀	27.3
		504	140♀	63.
		860	14♀	6.4
		1000	6♀	2.7
	8	505	20♀	35.1
		817	20♀	35.1
		955	16♂♀	28.1
		1625	1♀	1.8
	10	110	100♀	45.5
		500	27♀	12.3
		1000	20♀	9.1
		1800	5♀	2.3
		2200	8♀	3.6

TABLE 43 (continued)

Vertical distribution of Rhincalanus cornutus

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		2850	60♀	27.3
	11	500	40♀	44.4
		975	16♀	17.8
		1525	6♀	6.7
		1800	7♀	7.8
		2375	21♀	23.3
	12	500	60♀	87.0
		920	8♀	11.6
		1450	1♀	1.4
	13	100	100♀	73.0
		450	30♀	21.9
		1000	5♀	3.6
		1500	2♀	1.5
	14	1650	1♀	50.0
		2150	1♀	50.0
	16	398	21♀	72.4
		775	8♀	27.6
	18	100	150♀	73.5
		500	40♀	19.6
		1625	14♀	6.9
	20	250	60♀	87.0
		850	1♀	1.4
		1050	5♀	7.2
		1500	3♀	4.3
	22	100	30♀	11.7
		475	210♀	82.0
		1000	8♀	3.1
		1650	8♀	3.1
	24	1000	5♀	100.0
G-6722	4	335	15♀	68.2
		581	3♀	13.6
		1040	1♀	4.5
		1520	3♀	13.6
	9	320	10♀	100.0
	10	405	3♀	37.5
		630	2♀	25.0
		824	3♀	37.5
	12	310	2♀	15.4

TABLE 43 (continued)

Vertical distribution of Rhincalanus cornutus

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		675	6 ♀	46.2
		1150	5 ♂♀	38.5
	15	132	33 ♀	63.5
		450	5 ♀	9.6
		635	14 ♀	26.9
	17	55	10 ♀	2.2
		250	40 ♀	8.9
		525	57 ♀	12.7
		1000	304 ♂♀	67.9
		1500	7 ♀	1.6
		2000	30 ♂♀	6.7
P-6803	4	0	20 ♀	33.3
		100	40 ♀	66.7
	5	40	200 ♀	100.0
	8	40	400 ♀	24.7
		95	50 ♀	3.1
		175	1170 ♂♀	72.2
	11	580	270 ♀	69.9
		1030	66 ♀	17.1
		1500	42 ♀	10.9
		2500	8 ♀	2.1
	15	200	100 ♀	98.0
		750	2 ♀	2.0
	16	225	1 ♀	5.0
		420	14 ♀	70.0
		1000	5 ♀	25.0
	17	240	110 ♀	82.7
		490	20 ♀	15.0
		1000	3 ♀	2.3
	18	245	220 ♀	89.8
		1000	18 ♀	7.3
		1500	1 ♀	7.3
		2150	6 ♀	2.4
	20	125	20 ♀	25.0
		235	60 ♀	75.0
	22	470	20 ♀	62.5
		890	10 ♀	31.2

TABLE 43 (continued)

Vertical distribution of Rhincalanus cornutus

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1650	2♀	6.2
	25	750	8♀	25.0
		1000	24♀	75.0
	26	750	18♀	48.6
		1000	19♀	51.4
P-6805	2	440	35♀	53.8
		715	30♀	46.2
	3	250	120♀	54.5
		500	90♀	40.9
		1040	10♀	4.5
	4	500	150♀	96.8
		2000	5♀	3.2
	5	0	200♀	55.6
		250	40♀	11.1
		340	120♂♀	33.3
	7	0	200♀	5.6
		50	3000♂♀	84.4
		500	180♂♀	5.1
		1000	160♀	4.5
		1500	10♀	0.3
		2300	2♀	0.1
		2650	2♀	0.1
	9	65	100♀	3.1
		250	420♀	13.0
		500	2600♂♀	80.7
		981	90♂♀	2.8
		1438	12♀	0.4
	10	0	50♀	1.7
		55	50♀	1.7
		245	1450♀	49.3
		477	560♂♀	19.1
		995	820♀	27.9
		1500	8♀	0.3
		2256	1♀	0.0
	11	0	780♀	22.2
		250	1350♂♀	38.4

TABLE 43 (continued)

Vertical distribution of Rhincalanus cornutus

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		537	80 ♀	2.3
		1050	1300 ♂♀	37.0
		2263	2 ♂♀	0.1
		2550	2 ♂♀	0.1
P-6811	1	750	25 ♀	56.8
		950	15 ♀	34.1
		1380	2 ♀	4.5
		2025	2 ♀	4.5
	2	237	350 ♂♀	39.6
		508	200 ♀	22.6
		822	230 ♀	26.0
		1000	104 ♂♀	11.8
	3	500	180 ♂♀	64.7
		770	68 ♀	24.5
		1450	30 ♂♀	10.8
	4	270	380 ♂♀	39.9
		550	480 ♀	50.4
		1050	90 ♂♀	9.4
		1800	1 ♀	0.1
		3000	2 ♀	0.2
	5	25	300 ♀	12.9
		250	1250 ♂♀	53.6
		500	760 ♀	32.6
		750	20 ♂♀	0.9
		2850	1 ♀	0.0
	6	250	600 ♀	21.4
		485	1920 ♂♀	68.4
		720	280 ♂♀	10.0
		1000	5 ♀	0.2
	7	225	900 ♂♀	73.2
		275	180 ♀	14.6
		375	140 ♂♀	11.4
		500	10 ♀	0.8
	8	238	320 ♀	68.7
		480	50 ♀	10.7
		713	96 ♂♀	20.6
	9	50	500 ♀	24.2

TABLE 43 (continued)

Vertical distribution of Rhincalanus cornutus

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		230	600 ♂♀	29.1
		450	60 ♂♀	2.9
		635	900 ♂♀	43.6
		1525	5 ♀	0.2
	10	25	200 ♀	8.6
		250	1050 ♂♀	44.9
		500	1080 ♂♀	46.2
		750	7 ♀	0.3
		900	2 ♀	0.1
	11	285	225 ♀	31.0
		590	450 ♂♀	62.1
		800	50 ♀	6.9
	12	160	10 ♀	3.8
		290	190 ♀	72.5
		550	18 ♀	6.9
		775	36 ♂♀	13.7
		1100	8 ♀	3.1
	14	590	120 ♂♀	92.3
		800	10 ♂♀	7.7
	15	1000	10 ♀	83.3
		1325	2 ♀	16.7
	16	750	25 ♀	86.2
		1000	4 ♀	13.8
	17	485	60 ♀	57.1
		714	4 ♀	3.8
		1000	40 ♀	38.1
		1500	1 ♀	1.0
	18	525	60 ♂♀	61.2
		763	32 ♀	32.7
		1050	4 ♀	4.1
		1500	2 ♀	2.0
	19	320	60 ♀	71.4
		700	6 ♀	7.1
		800	6 ♀	7.1
		1250	12 ♀	14.3
	20	500	280 ♀	82.1
		750	60 ♀	17.6

TABLE 43 (continued)

Vertical distribution of <u>Rhincalanus</u> <u>cornutus</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1000	1♀	0.3
P-6904	1	38	250♀	89.3
		415	10♀	3.6
		1450	20♂♀	7.1
	2	265	120♀	40.0
		500	170♀	56.7
		1150	10♀	3.3
	3	265	480♂♀	88.2
		550	60♀	11.0
		800	2♀	0.4
		1700	2♀	0.4
	4	950	2♀	100.0
	5	250	320♂♀	69.6
		500	120♂♀	26.1
		1033	20♀	4.3
	6	232	50♀	94.3
		1000	3♂♀	5.7
	7	737	100♀	58.1
		918	70♀	40.7
		1404	2♂	1.2
	9	467	210♀	47.1
		676	200♂♀	44.8
		1000	36♂♀	8.1
	10	233	80♀	14.4
		455	170♂♀	30.6
		663	130♀	23.4
		981	128♂♀	23.0
		1484	35♀	6.3
		1892	11♀	2.0
		2394	2♀	0.4
	11	45	100♀	24.3
		262	7♀	1.7
		524	190♀	46.2
		759	60♀	14.6
		1036	54♂♀	13.1
	12	259	80♀	43.5
		515	50♀	27.2

TABLE 43 (continued)

Vertical distribution of Rhincalanus cornutus

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		781	45♀	24.5
		1036	9♀	4.9
	13	524	16♀	33.3
		753	24♀	50.0
		1019	6♀	12.5
		1638	2♀	4.2
	14	734	30♀	61.2
		1052	12♂♀	24.5
		1454	2♀	4.1
		1828	1♀	2.0
		2336	4♀	8.2
	15	0	10♀	20.8
		791	20♀	41.7
		1500	11♀	22.9
		1816	6♀	12.5
		2248	1♀	2.1
	16	761	2♀	22.2
		974	7♀	77.8
	17	750	90♂♀	78.3
		971	18♀	15.7
		1408	7♀	6.1
	18	531	20♀	21.1
		802	55♀	57.9
		1033	2♀	2.1
		1747	12♀	12.6
		1942	6♀	6.3
	19	550	30♀	50.8
		904	3♀	5.1
		1248	6♀	10.2
		1583	14♀	23.7
		1986	6♀	10.2
	20	258	1♀	2.9
		537	9♀	25.7
		827	18♀	51.4
		1588	7♀	20.0
	21	220	350♀	79.0
		297	80♀	18.1

TABLE 43 (continued)

Vertical distribution of Rhincalanus cornutus

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		431	4 ♀	0.9
		490	9 ♀	2.0
	22	252	30 ♀	3.7
		372	20 ♀	2.5
		450	210 ♀	26.2
		554	420 ♂♀	52.5
		620	120 ♀	15.0
P-6911	1	459	40 ♂♀	23.5
		715	27 ♀	15.9
		911	48 ♀	28.2
		1371	42 ♂♀	24.7
		1835	5 ♀	2.9
		2337	8 ♀	4.7
	2	242	450 ♀	31.9
		533	780 ♂♀	55.3
		844	8 ♀	0.6
		1272	172 ♀	12.2
	3	274	550 ♀	36.3
		494	350 ♂♀	23.1
		739	180 ♀	11.9
		1040	425 ♂♀	28.1
		1567	9 ♀	0.6
	4	81	100 ♀	11.8
		218	340 ♀	40.1
		423	220 ♀	26.0
		836	150 ♀	17.7
		1338	36 ♀	4.3
		1844	1 ♀	0.1
	5	59	450 ♀	22.2
		237	1200 ♀	59.2
		472	40 ♀	2.0
		698	7 ♀	0.3
		996	310 ♀	15.3
		1878	6 ♀	0.3
		2474	14 ♂♀	0.7
	6	50	50 ♀	5.0
		481	400 ♀	40.2

TABLE 43 (continued)

Vertical distribution of Rhincalanus cornutus

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		665	40♀	4.0
		888	10♀	1.0
		1324	495♂♀	49.7
	7	253	480♀	32.2
		539	580♀	38.9
		779	190♀	12.7
		1000	18♀	1.2
		1300	224♀	15.0
	8	243	30♀	6.8
		510	240♀	54.3
		995	12♂♀	2.7
		1548	156♀	35.3
		2316	4♀	0.9
	9	250	450♀	47.1
		515	240♀	25.1
		1006	42♀	4.4
		1580	219♂♀	22.9
		2088	1♀	0.1
		2454	4♂♀	0.4
	10	0	50♀	3.5
		227	640♀	45.2
		480	580♂♀	41.0
		975	46♀	3.3
		1500	78♀	5.5
		2032	16♀	1.1
		2118	4♀	0.3
		3176	1♀	0.1
	11	234	270♀	39,2
		491	180♂♀	26.1
		969	153♂♀	22.2
		1570	66♀	9.6
		2104	17♀	2.5
		2490	2♀	0.3
		3602	1♀	0.1
	12	153	20♀	2.6
		200	4♀	0.5
		258	51♀	6.7
		296	120♀	15.7

TABLE 43 (continued)

Vertical distribution of Rhincalanus cornutus

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		344	100 ♀	13.1
		410	200 ♂♀	26.1
		465	270 ♀	35.3
	13	269	60 ♀	42.3
		500	32 ♀	22.5
		1036	8 ♀	5.6
		1601	36 ♀	25.4
		2232	6 ♀	4.2
	14	520	16 ♀	22.5
		785	25 ♀	35.2
		954	14 ♀	19.7
		1443	16	22.5
	15	445	15 ♀	24.6
		970	28 ♂♀	45.9
		1424	10 ♀	16.4
		1998	8 ♀	13.1
	16	478	3 ♀	13.6
		1525	9 ♀	40.9
		2032	10 ♀	45.5
	17	514	30 ♀	37.5
		1039	15 ♀	18.7
		1590	18 ♂♀	22.5
		2216	17 ♀	21.2

TABLE 44

Vertical distribution of Scolecithrix danae

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6606	4	103	1200 ♂♀	96.0
		285	50 ♀	4.0
	8	100	600 ♂♀	100.0
	12	100	400 ♂♀	100.0
	13	100	50 ♂♀	100.0
P-6701	3	0	10 ♀	66.7
		115	5 ♀	33.3
	5	0	50 ♀	33.3
		90	100 ♂♀	66.7
	8	0	100 ♀	100.0
	10	110	600 ♂♀	99.8
		500	1 ♀	0.2
	11	110	50 ♀	100.0
	12	100	400 ♂♀	100.0
	13	100	300 ♂♀	100.0
	14	100	150 ♂♀	97.4
		500	4 ♂♀	2.6
	16	100	220 ♂♀	100.0
	18	0	100 ♀	66.7
		100	50 ♀	33.3
	22	1650	2 ♂♀	100.0
G-6722	9	155	30 ♀	100.0
	10	45	200 ♂♀	100.0
	12	80	350 ♂♀	94.6
		181	20 ♀	5.4
	15	30	20 ♀	76.9
		132	6 ♀	23.1
P-6803	4	30	150 ♂♀	68.2
		100	70 ♀	31.8
	5	40	50 ♂	100.0
	8	0	20 ♀	1.0
		40	2050 ♂♀	99.0
	11	30	2400 ♂♀	99.7
		2500	8 ♀	0.3
	15	200	20 ♀	100.0

TABLE 44 (continued)

Vertical distribution of Scolecithrix danae

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	16	100	80 ♀	100.0
	18	100	720 ♂♀	100.0
	26	100	80 ♂♀	100.0
P-6805	2	0	300 ♂♀	98.4
		440	5 ♂	1.6
	5	96	20 ♀	100.0
	7	50	600 ♂♀	100.0
	9	65	300 ♂♀	90.9
		250	30 ♀	9.1
	10	0	50 ♀	4.3
		55	1100 ♂♀	95.7
P-6811	1	38	100 ♀	100.0
	4	50	1600 ♂♀	100.0
	5	25	600 ♀ imm.	100.0
	6	0	100 ♀	100.0
	8	238	60 ♀	100.0
	9	50	100 ♂♀	99.0
		875	1 ♀	1.0
	10	0	300 ♀	46.2
		25	350 ♀	53.8
	14	40	500 ♂♀	100.0
	18	114	150 ♀ imm.	100.0
P-6904	1	0	50 ♂	10.0
		38	450 ♂♀	90.0
	2	14	250 ♀	100.0
	3	30	550 ♂♀	94.8
		265	30 ♀	5.2
	6	31	120 ♀	100.0
	7	25	100 ♀	100.0
	13	0	50 ♀	33.3
		48	100 ♂♀	66.7
	15	261	12 ♀	100.0
	20	258	1 ♀	100.0
P-6911	2	53	250 ♂	100.0

TABLE 44 (continued)

Vertical distribution of <u>Scolecithrix danae</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	3	60	800 ♂♀	100.0
	4	81	100 ♀	100.0
	5	59	30 ♀	100.0
	6	50	50 ♀	100.0
	7	60	20 ♀	100.0
	8	243	30 ♀	100.0
	9	0	100 ♀	14.2
		60	600 ♂♀	85.5
		2088	2 ♀	0.3
	10	56	700 ♂♀	94.6
		227	40 ♀	5.4
	11	0	150 ♀	100.0
	12	36	20 ♀	3.8
		78	500 ♂♀	95.8
		200	2 ♀	0.4
	13	65	50 ♀	100.0
	14	34	200 ♀	100.0
	15	53	80 ♂♀	100.0

TABLE 45

Vertical Distribution of Undinula vulgaris

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6606	4	0	5600 ♂♀ imm.	83.3
		103	1100 ♂♀	16.4
		285	25 ♀	0.4
	8	0	350 ♂♀	100.0
	12	0	250 ♀	100.0
	13	0	50 ♀	100.0
P-6701	3	0	130 ♂♀	100.0
	4	0	30 ♂♀	100.0
	5	0	400 ♂♀	100.0
	8	0	100 ♂	100.0
	10	110	250 ♂♀	100.0
	12	100	1250 ♂♀	100.0
	13	100	1250 ♂♀	100.0
	14	100	600 ♂♀	100.0
	16	100	680 ♂♀	100.0
	18	0	3850 ♂♀	99.9
		1000	1 ♀	0.0
G-6722	4	0	100 ♀	100.0
	10	0	100 ♂♀	62.5
		45	60 ♀	37.5
	12	0	1600 ♂♀	97.0
		80	50 ♂	3.0
	15	0	420 ♂♀	100.0
	17	55	70 ♂♀	100.0
P-6803	4	0	280 ♂♀	96.6
		30	10 ♂	3.4
	11	30	700 ♂♀	100.0
	18	100	4000 ♂♀	99.8
		480	10 ♂	0.2
	25	0	20 ♀	100.0
P-6805	2	0	11300 ♂♀	100.0
	4	0	350 ♀	100.0
	7	0	100 ♀	12.5

TABLE 45 (continued)

Vertical Distribution of <u>Undinula</u> <u>vulgaris</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER		PER CENT
		50	700 ♂♀		87.5
	10	0	50 ♀		50.0
		55	50 ♀		50.0
P-6811	1	0	2250 ♂♀		100.0
	2	0	10	imm.	100.0
	4	50	5900 ♂♀		100.0
	5	25	200 ♂♀		100.0
	6	0	100 ♂		100.0
	9	0	400 ♀		100.0
	10	0	900 ♂♀		100.0
	11	0	1500 ♂♀	imm.	100.0
	14	40	150 ♂♀		100.0
	18	0	850 ♂♀		100.0
	19	0	500 ♂♀		100.0
	20	75	600 ♂♀		99.7
		250	2 ♀		0.3
P-6904	1	0	1300 ♂♀		78.8
		38	350 ♂♀		21.2
	2	14	200 ♂♀		100.0
	4	0	3030 ♀	imm.	100.0
	6	31	160 ♂♀		100.0
	7	25	1450 ♂♀		100.0
	9	0	35 ♂♀		30.4
		70	80 ♂♀		69.6
	13	0	2300 ♂♀		100.0
	16	0	28 ♂♀	imm.	100.0
	17	0	120 ♀		100.0
	18	0	40 ♂♀		25.0
		62	120 ♂♀		75.0
	21	0	10 ♀		0.5
		50	1850 ♂♀		99.5
P-6911	1	0	150 ♂♀		100.0
	2	0	400 ♂♀		100.0
	4	0	60 ♀		54.5
		81	50 ♀		45.5

TABLE 45 (continued)

Vertical Distribution of Undinula vulgaris

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	5	0	5 ♀	2.3
		59	210 ♀	97.7
	7	0	8 ♀	1.1
		60	740 ♂♀	98.9
	9	0	1350 ♂♀	100.0
	10	0	250 ♂♀	100.0
	11	0	250 ♂♀	55.6
		58	200 ♀	44.4
	12	78	1040 ♂♀	100.0
	13	0	700 ♂♀	100.0
	14	0	30 ♀	13.0
		34	200 ♀	87.0
	15	53	480 ♂♀	100.0
	16	0	60 ♂♀	100.0
	17	0	10 ♀	100.0

TABLE 46

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6606	4	0	2800	16.7
		103	13000	77.6
		285	375	2.2
		593	225	1.3
		700	260	1.6
		1000	90	0.5
	8	0	7550	32.6
		100	10400	44.9
		500	3720	16.1
		1000	1470	6.3
		2000	35	0.2
		3250	1	0.0
	11	0	5100	33.4
		100	4450	29.2
		500	5600	36.7
		1000	30	0.2
		2000	80	0.5
		2500	4	0.0
	12	0	39600	76.0
		100	10800	20.7
		300	1620	3.1
		500	2	0.0
		1500	75	0.1
	13	0	2450	8.2
		100	23700	79.5
		300	2620	8.8
		500	940	3.2
		1000	95	0.3
		1300	1	0.0
	14	10	40300	83.7
		100	7850	16.3
P-6701	1	0	1340	32.5
		530	1050	25.5
		845	208	5.0
		1250	14	0.3
		1725	1330	32.3

TABLE 46 (continued)

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		2425	182	4.4
	2	0	1010	7.8
		90	4500	34.6
		220	1490	11.5
		350	5480	42.2
		500	408	3.1
		575	109	0.8
	3	0	1720	23.0
		115	1310	17.5
		250	1820	24.4
		350	1590	21.3
		435	442	5.9
		750	202	2.7
		970	384	5.1
	4	0	675	67.7
		130	8	0.8
		505	232	23.3
		1000	42	4.2
		1338	15	1.5
		2500	14	1.4
		3500	11	1.1
	5	0	20500	53.7
		90	14600	38.2
		250	1430	3.7
		504	1190	3.1
		860	422	1.1
		1000	42	0.1
		1830	19	0.0
	8	0	40100	88.2
		70	49	0.1
		250	3340	7.3
		505	1640	3.6
		817	260	0.6
		955	74	0.2
		1625	14	0.0
	10	0	690	6.0
		110	8450	73.3

TABLE 46 (continued)

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		500	129	1.1
		1000	1210	10.5
		1800	575	5.0
		2200	122	1.1
		2850	351	3.0
	11	0	234	0.7
		110	30500	93.4
		500	1600	4.9
		975	206	0.6
		1525	26	0.1
		1800	32	0.1
		2375	63	0.2
	12	0	1400	15.4
		100	6750	74.1
		500	730	8.0
		920	132	1.4
		1450	37	0.4
		1825	24	0.3
		2450	19	0.2
		3100	7	0.1
		3200	13	0.1
	13	0	60000	83.5
		100	7350	10.2
		450	4200	5.8
		1000	255	0.4
		1500	14	0.0
		1950	1	0.0
		3100	22	0.0
		3200	8	0.0
	14	0	49200	89.9
		100	5350	9.8
		500	68	0.1
		1000	2	0.0
		1650	44	0.1
		2150	34	0.1
		2375	11	0.0
		3850	6	0.0
		4350	33	0.1

TABLE 46 (continued)

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	16	0	3450	69.2
		100	1020	20.5
		398	429	8.6
		775	44	0.9
		1250	40	0.8
	18	0	28800	68.5
		100	8950	21.3
		500	3920	9.3
		1000	55	0.1
		1625	40	0.1
		2200	110	0.3
		2650	28	0.1
		3800	71	0.2
		4350	97	0.2
	20	0	2	0.0
		100	4	0.1
		250	4020	96.8
		450	3	0.1
		850	49	1.2
		1050	51	1.2
		1500	25	0.6
	22	0	3320	25.6
		100	6120	47.2
		475	3150	24.3
		1000	136	1.0
		1650	65	0.5
		2000	92	0.7
		2350	91	0.7
	24	0	3100	8.9
		100	30200	86.4
		500	1500	4.3
		1000	93	0.3
		1800	3	0.0
		2600	30	0.1
		3000	34	0.1
G-6722	4	0	12800	36.8

TABLE 46 (continued)

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		55	21500	61.9
		335	380	1.1
		581	13	0.0
		1040	11	0.0
		1520	44	0.1
	9	0	22600	50.4
		40	20900	46.6
		155	630	1.4
		320	555	1.2
		562	37	0.1
		875	52	0.1
		1200	29	0.1
	10	0	24800	92.9
		45	1030	3.9
		225	270	1.0
		405	276	1.0
		630	206	0.8
		824	13	0.0
		1800	59	0.2
		3000	2	0.0
		3500	39	0.1
		4500	10	0.0
	12	0	61700	82.8
		80	11700	15.7
		181	930	1.2
		310	78	0.1
		675	74	0.1
		1150	26	0.0
	15	0	3140	71.1
		30	850	19.3
		132	231	5.2
		240	3	0.1
		450	15	0.3
		635	176	4.0
	17	0	20000	86.9
		55	490	2.1
		250	1940	8.4
		525	393	1.7

TABLE 46 (continued)

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1000	49	0.2
		1500	29	0.1
		2000	112	0.5
P-6803	4	0	3500	7.9
		30	39800	90.0
		100	930	2.1
	5	0	16500	38.6
		40	26200	61.4
	8	0	3640	5.3
		40	55700	80.3
		95	6000	8.7
		175	3990	5.8
	11	0	2520	7.6
		30	27500	83.2
		580	2340	7.1
		1030	408	1.2
		1500	130	0.4
		2000	33	0.1
		2500	128	0.4
	15	0	2180	5.9
		100	29600	79.6
		200	3660	9.8
		400	1550	4.2
		750	89	0.2
		995	85	0.2
		1200	5	0.0
	16	0	5720	70.4
		100	1880	23.1
		225	21	0.3
		420	366	4.5
		1000	75	0.9
		1500	36	0.4
		3000	26	0.3
	17	0	15400	76.7
		100	1440	7.2
		240	1370	6.8
		490	1640	8.2

TABLE 46 (continued)

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1000	183	0.9
		2200	29	0.1
		3000	7	0.0
	18	0	3660	21.9
		100	6680	40.0
		245	4800	28.7
		480	1270	7.6
		1000	165	1.0
		1500	53	0.3
		2150	54	0.3
		2200	6	0.0
		3500	23	0.1
	20	0	105	0.8
		75	9380	67.2
		125	2540	18.2
		235	1240	8.9
		475	580	4.2
		740	111	0.8
	22	0	890	2.3
		100	33200	84.4
		200	4050	10.3
		470	960	2.4
		890	188	0.5
		1650	41	0.1
		3000	14	0.0
	25	0	4660	62.6
		100	35	0.5
		250	1740	23.4
		500	390	5.2
		750	282	3.8
		1000	231	3.1
		1425	110	1.5
	26	0	18	0.2
		100	5560	59.3
		150	29	0.3
		480	2780	29.6
		750	664	7.1
		1000	329	3.5

TABLE 46 (continued)

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6805	2	0	1420	23.8
		100	1390	23.3
		250	2340	39.2
		440	380	6.4
		715	350	5.9
		1000	65	1.1
		1500	20	0.3
	3	0	43100	71.4
		100	9350	15.5
		250	6060	10.0
		500	1650	2.7
		1040	130	0.2
		1583	29	0.1
		2250	29	0.1
		2400	16	0.0
	4	0	18600	47.0
		90	17900	45.2
		500	2750	6.9
		1010	270	0.7
		1500	5	0.0
		2000	65	0.2
		2323	3	0.0
		3350	2	0.0
		4000	19	0.0
	5	0	15000	68.8
		96	36[illegible]0	16.9
		250	1680	7.7
		340	1350	6.2
		500	90	0.4
		770	9	0.0
	7	0	1900	7.1
		50	23700	89.1
		500	370	1.4
		1000	590	2.2
		1500	16	0.1
		2300	9	0.0
		2650	15	0.1
	9	0	1600	23.4

TABLE 46 (continued)

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		65	1900	27.7
		250	810	11.8
		500	2400	35.0
		981	105	1.5
		1438	16	0.2
		2026	18	0.3
	10	0	350	5.7
		55	1650	27.0
		245	1700	27.8
		477	2200	36.0
		995	170	2.8
		1500	19	0.3
		2256	17	0.3
		2500	5	0.1
	11	0	120	3.7
		250	1550	47.6
		537	1260	38.7
		1050	240	7.4
		1700	30	0.9
		2263	11	0.3
		2550	38	1.2
		4517	5	0.2
P-6811	1	0	22000	54.2
		38	14800	36.4
		250	2580	6.4
		500	740	1.8
		750	230	0.6
		950	195	0.5
		1380	34	0.1
		2025	33	0.1
	2	0	560	3.5
		77	9150	56.4
		237	4900	30.2
		508	910	5.6
		822	540	3.3
		1000	136	0.8
		1200	16	0.1

TABLE 46 (continued)

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	3	0	52500	91.3
		63	8	0.0
		225	4080	7.1
		500	470	0.8
		770	400	0.7
		1450	40	0.1
		1800	7	0.0
	4	0	25700	41.0
		50	29300	46.7
		270	1220	1.9
		550	6280	10.0
		1050	100	0.2
		1800	40	0.1
		2150	2	0.0
		2312	12	0.0
		3000	32	0.1
		3250	19	0.0
	5	0	9850	21.9
		25	23400	52.0
		250	10200	22.6
		500	1480	3.3
		750	50	0.1
		1016	15	0.0
		1823	21	0.0
		2450	15	0.0
		2850	12	0.0
	6	0	9900	29.8
		25	17400	52.3
		250	2640	7.9
		485	2130	6.4
		720	1110	3.3
		1000	10	0.0
		1750	14	0.1
		2025	74	0.2
		2525	9	0.0
	7	0	1530	4.5
		90	8480	25.2

TABLE 46 *(continued)*

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		125	3540	10.5
		225	10400	30.9
		275	3180	9.4
		375	4980	14.8
		500	1550	4.6
	8	0	1860	24.9
		27	240	3.2
		238	3220	43.1
		480	670	9.0
		713	1120	15.0
		1000	250	3.3
		1500	88	1.2
		2000	16	0.2
		2450	5	0.1
	9	0	1500	3.1
		50	39900	83.4
		230	3450	7.2
		450	120	0.3
		635	2780	5.8
		875	12	0.0
		1400	17	0.0
		1525	65	0.1
		2350	1	0.0
	10	0	25800	52.3
		25	18700	37.9
		250	2350	4.8
		500	2190	4.4
		750	67	0.1
		900	25	0.1
		1000	196	0.4
	11	0	53500	81.8
		45	7550	11.5
		285	1920	2.9
		590	2070	3.2
		800	295	0.5
		1200	6	0.0
		1400	60	0.1
	12	0	1950	10.2

TABLE 46 (continued)

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		35	14100	73.7
		160	1120	5.9
		290	1540	8.0
		550	87	0.5
		775	196	1.0
		1100	144	0.8
	14	0	14300	66.9
		40	4600	21.5
		285	1540	7.2
		590	670	3.1
		800	90	0.4
		1175	10	0.0
		1700	75	0.4
		1875	11	0.1
		2375	12	0.1
		2850	59	0.3
	15	0	10900	65.7
		55	860	5.2
		237	4380	26.4
		470	275	1.7
		1000	52	0.3
		1325	90	0.5
		1500	19	0.1
		1950	20	0.1
	16	0	6050	25.1
		52	15000	62.3
		250	2300	9.6
		500	142	0.6
		750	470	2.0
		1000	74	0.3
		1500	28	0.1
		2150	8	0.0
		2550	5	0.0
	17	0	1110	4.5
		85	17800	71.7
		237	3630	14.6
		485	2020	8.1
		714	66	0.3

TABLE 46 (continued)

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1000	150	0.6
		1500	24	0.1
		1950	15	0.1
		2375	12	0.0
		3500	9	0.0
	18	0	35000	76.9
		114	5800	12.7
		260	3090	6.8
		525	1100	2.4
		763	408	0.9
		1050	62	0.1
		1500	25	0.1
		1900	13	0.0
		2500	21	0.0
		3500	5	0.0
	19	0	10200	85.4
		75	63	0.5
		320	1320	11.1
		700	174	1.5
		800	64	0.5
		1250	60	0.5
		1500	10	0.1
		1625	26	0.2
		1850	19	0.2
		2350	2	0.0
	20	0	7290	33.1
		75	12400	56.4
		250	[illegible]	0.5
		500	1880	8.5
		750	270	1.2
		1000	37	0.2
P-6904	1	0	26000	53.9
		38	20900	43.4
		215	55	0.1
		415	1030	2.1
		795	1	0.0
		1125	11	0.0

TABLE 46 (continued)

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1450	210	0.4
	2	0	35000	61.9
		14	17700	31.3
		265	1460	2.6
		500	1510	2.7
		1150	880	1.6
	3	0	13300	23.6
		30	39000	69.3
		265	2430	4.3
		550	1470	2.6
		800	28	0.0
		1050	6	0.0
		1700	40	0.1
		2000	11	0.0
		2250	1	0.0
	4	0	2910	22.5
		30	2820	21.8
		230	3320	25.7
		470	3820	29.5
		950	29	0.2
		1925	7	0.1
		2380	5	0.0
		3410	4	0.0
		3560	27	0.2
	5	0	2880	6.6
		21	34700	79.7
		250	4040	9.3
		500	1260	2.9
		1033	570	1.3
		1534	9	0.0
		2000	22	0.1
		2620	15	0.0
		3655	17	0.0
		4105	8	0.0
	6	0	4450	36.1
		31	4120	33.5
		232	3450	28.0
		418	19	0.2
		1000	137	1.1

TABLE 46 (continued)

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1500	24	0.2
		2042	7	0.1
		2575	18	0.1
		3144	65	0.5
		3594	18	0.1
		4000	1	0.0
		5000	1	0.0
	7	0	150	1.8
		25	4300	50.6
		241	1320	15.5
		452	1140	13.4
		737	1050	12.4
		918	510	6.0
		1404	24	0.3
	9	0	165	1.6
		70	1780	16.8
		236	4650	43.8
		467	3060	28.8
		676	800	7.5
		1000	152	1.4
	10	0	68	0.9
		30	3180	44.1
		233	930	12.9
		455	1790	24.8
		663	950	13.2
		981	184	2.5
		1484	45	0.6
		1665	1	0.0
		1892	39	0.5
		2394	30	0.4
	11	0	46600	60.0
		45	27600	35.5
		262	1820	2.3
		524	1310	1.7
		759	285	0.4
		1036	86	0.1
	12	0	4590	11.6

TABLE 46 (continued)

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		30	32300	81.8
		259	1310	3.3
		515	850	2.2
		781	335	0.8
		1036	87	0.2
	13	0	11100	50.1
		48	8850	40.0
		258	550	2.5
		524	1140	5.1
		753	366	1.7
		1019	78	0.4
		1638	20	0.1
		2115	17	0.1
		2612	11	0.0
		3474	4	0.0
	14	0	275	3.0
		37	2520	27.5
		239	4590	50.0
		458	1160	12.6
		734	465	5.1
		1052	42	0.5
		1454	82	0.9
		1828	33	0.4
		2336	7	0.1
	15	0	590	3.9
		52	11000	72.5
		261	1320	8.7
		524	1900	12.5
		791	184	1.2
		1057	104	0.7
		1500	35	0.2
		1816	15	0.1
		2248	12	0.1
		3288	5	0.0
	16	0	266	1.3
		59	16200	79.4
		253	3820	18.7

TABLE 46 (continued)

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		519	21	0.1
		761	19	0.1
		974	61	0.3
		1500	24	0.1
	17	0	1090	14.1
		45	4380	56.7
		251	1540	19.9
		750	570	7.4
		971	90	1.2
		1408	61	0.8
	18	0	225	2.4
		62	2580	27.6
		261	2610	27.9
		531	3380	36.2
		802	305	3.3
		1033	114	1.2
		1532	25	0.3
		1747	37	0.4
		1942	39	0.4
		2540	29	0.3
	19	0	320	1.1
		30	23900	81.8
		274	3180	10.9
		550	1610	5.5
		904	97	0.3
		1248	53	0.2
		1583	31	0.1
		1986	9	0.0
		2524	12	0.0
	20	0	1170	2.3
		10	48200	95.7
		258	281	0.6
		537	405	0.8
		827	315	0.6
		1052	3	0.0
		1588	7	0.0
	21	0	1020	5.2

TABLE 46 (continued)

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		50	13600	69.6
		220	2300	11.8
		297	1380	7.1
		431	456	2.3
		490	783	4.0
	22	0	188	0.6
		40	12300	40.0
		252	6810	22.2
		372	2610	8.5
		450	4230	13.8
		554	3380	11.0
		620	1220	4.0
P-6911	1	0	5190	34.7
		65	2950	19.7
		250	4650	31.1
		459	1460	9.8
		715	285	1.9
		911	261	1.7
		1371	82	0.5
		1835	54	0.4
		2337	17	0.1
	2	0	9300	40.4
		53	9750	42.3
		242	2670	11.6
		533	1200	5.2
		844	40	0.2
		1272	72	0.3
	3	0	159	0.6
		60	17900	68.1
		274	5850	22.3
		494	1550	5.9
		739	384	1.5
		1040	345	1.3
		1567	42	0.2
		2072	45	0.2
		2556	4	0.0
	4	0	2080	19.2

TABLE 46 (continued)

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		81	6200	57.3
		218	980	9.1
		423	1220	11.3
		836	300	2.8
		1338	12	0.1
		1844	35	0.3
	5	0	845	5.5
		59	3390	22.1
		237	7900	51.4
		472	2780	18.1
		698	71	0.5
		996	170	1.1
		1878	196	1.3
		2474	19	0.1
	6	0	2260	10.5
		50	16900	78.5
		240	19	0.1
		481	1820	8.4
		665	296	1.4
		888	94	0.4
		1324	153	0.7
	7	0	208	2.8
		60	780	10.6
		253	2880	39.0
		539	2400	32.5
		779	990	13.4
		1000	29	0.4
		1300	104	1.4
	8	0	201	1.4
		60	6250	43.3
		243	5430	37.7
		510	2360	16.4
		995	22	0.2
		1548	24	0.2
		2088	46	0.3
		2316	60	0.4
		3304	13	0.1
		3942	16	0.1
	9	0	15700	53.0

TABLE 46 (continued)

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		60	9550	32.2
		250	3700	12.5
		515	400	1.3
		1006	168	0.6
		1580	39	0.1
		2088	25	0.1
		2454	26	0.1
		3442	18	0.1
		3910	6	0.0
	10	0	6700	23.6
		56	17100	60.2
		227	2360	8.3
		480	1860	6.6
		975	104	0.4
		1500	60	0.2
		2032	32	0.1
		2118	98	0.3
		2660	55	0.2
		3176	13	0.0
	11	0	8600	44.0
		58	7400	37.9
		234	2670	13.7
		491	475	2.4
		969	168	0.9
		1570	62	0.3
		2104	47	0.2
		2490	77	0.4
		3602	21	0.1
		4096	13	0.1
	12	0	351	1.9
		36	1280	6.8
		78	1420	7.5
		153	1560	8.2
		200	84	0.4
		258	231	1.2
		296	3000	15.8
		344	3860	20.4
		410	3440	18.2
		465	3720	19.6

TABLE 46 (continued)

Vertical distribution of other Calanoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	13	0	9050	38.5
		65	12900	54.9
		269	730	3.1
		500	488	2.1
		1036	57	0.2
		1601	156	0.7
		2232	53	0.2
		2862	45	0.2
		5200	33	0.1
	14	0	8160	21.2
		34	29500	76.7
		265	26	0.1
		520	182	0.5
		785	410	1.1
		954	98	0.3
		1443	72	0.2
	15	0	12000	44.5
		53	8200	30.4
		224	4680	17.3
		445	1600	5.9
		970	352	1.3
		1424	32	0.1
		1998	37	0.1
		2950	22	<0.1
		3932	24	<0.1
		4556	12	<0.1
		6220	11	<0.1
		7000	6	<0.1
		7500	24	<0.1
	16	0	11400	33.8
		51	19900	59.0
		243	1840	5.5
		478	489	1.4
		1012	30	0.1
		1525	34	0.1
		2032	39	0.1
	17	0	1090	4.0
		54	19700	72.4
		261	4290	15.8
		514	1760	6.5
		1039	303	1.1
		1590	44	0.2
		2216	36	0.1

TABLE 47

Vertical distribution of *Aegisthus aculeatus*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6606	8	0	350 ♀	81.4
		1000	75 ♀	17.4
		2000	5 ♀	1.2
	11	2000	20 ♀	100.0
	12	100	100 ♀	94.3
		1000	1 ♀	0.9
		1500	5 ♀	4.7
	13	500	20 ♀	80.0
		1000	5 ♀	20.0
P-6701	1	1725	15 ♀	100.0
	2	500	2 ♀	100.0
	3	750	3 ♂♀	60.0
		970	2 ♂	40.0
	4	1338	1 ♀	100.0
	5	1000	1 ♀	100.0
	8	817	5 ♀	71.4
		955	2 ♀	28.6
	10	1000	5 ♀	71.4
		2200	2 ♀	28.6
	11	975	6 ♂♀	50.0
		1525	2 ♀	16.7
		1800	1 ♀	8.3
		2375	3 ♀	25.0
	12	920	6 ♀	100.0
	13	1000	5 ♂	71.4
		1500	2 ♀	28.6
	14	1000	1 ♀	50.0
		2150	1 ♀	50.0
	16	775	2 ♀	100.0
	18	1625	1 ♀	20.0
		2200	3 ♀	60.0
		4350	1 ♀	20.0
	20	1050	3 ♀	100.0
	22	1650	2 ♀	100.0
	24	1000	1 ♀	100.0

TABLE 47 (continued)

Vertical distribution of <u>Aegisthus aculeatus</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
G-6722	12	675	4♀	100.0
	15	450	1♀	100.0
	17	1000	2♀	100.0
P-6803	4	100	10♀	100.0
	11	1030	18 ♂♀	100.0
	15	750	3♀	75.0
		995	1♀	25.0
	16	1000	3♀	100.0
	17	2200	1♀	100.0
	18	1000	3♀	50.0
		1500	2♀	33.3
		2200	1♀	16.7
	20	740	3♀	100.0
	22	890	8 ♂♀	100.0
	26	750	4 ♂♀	100.0
P-6805	2	715	10♀	50.0
		1500	10♀	50.0
	3	1040	10♀	100.0
	4	2000	10♀	100.0
	7	1000	10♀	90.9
		1500	1♀	9.1
	9	1438	2♀	100.0
	10	1500	1♀	50.0
		2256	1♀	50.0
	11	250	50♀	94.3
		1700	3♀	5.7
P-6811	1	1380	7♀	100.0
	2	822	20♀	100.0
	3	1450	16♀	100.0
	4	1050	15♀	83.3
		1800	3♀	16.7
	5	1823	1♀	100.0
	6	720	20♀	76.9
		1000	1♀	3.8

TABLE 47 (continued)

Vertical distribution of <u>*Aegisthus aculeatus*</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1750	2 ♀	7.7
		2025	2 ♀	7.7
		2525	1 ♀	3.8
	8	1000	10 ♀	62.5
		1500	4 ♀	25.0
		2000	2 ♀	12.5
	9	635	100 ♀	90.9
		1525	10 ♀	9.1
	10	1000	16 ♂♀	100.0
	11	1400	4 ♀	100.0
	12	290	20 ♀	66.7
		1100	10 ♂♀	33.3
	14	1700	9 ♀	90.0
		1875	1 ♀	10.0
	15	1000	2 ♀	14.3
		1325	6 ♀	42.9
		1500	4 ♀	28.6
		1950	2 ♀	14.3
	16	1500	4 ♀	100.0
	17	714	4 ♀	40.0
		1500	5 ♂♀	50.0
		1950	1 ♀	10.0
	18	525	20 ♀	71.4
		1050	4 ♀	14.3
		1500	2 ♀	7.1
		1900	1 ♀	3.6
		2500	1 ♀	3.6
	19	700	6 ♀	40.0
		800	4 ♀	26.7
		1250	2 ♀	13.3
		1625	3 ♀	20.0
P-6904	3	1700	4 ♀	100.0
	4	950	1 ♀	100.0
	5	500	20 ♀	76.9
		1033	5 ♀	19.2
		4105	1 ♀	3.8

TABLE 47 (continued)

Vertical distribution of <u>Aegisthus aculeatus</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	6	1000	1♀	33.3
		2042	1♀	33.3
		2575	1♀	33.3
	7	737	10♀	33.3
		918	20♀	66.7
	9	676	80♂♀	90.9
		1000	8♀	9.1
	10	663	40♂♀	75.5
		981	8♀	15.1
		1484	5♀	9.4
	11	1036	10♂♀ imm.	100.0
	12	781	10♀	76.9
		1036	3♀	23.1
	13	753	6♀	46.2
		1019	6♀	46.2
		1638	1♀	7.7
	14	1454	2♀	66.7
		1828	1♀	33.3
	17	971	3♀	37.5
		1400	5♀	62.5
	18	1033	2♂	100.0
	19	904	2♀	50.0
		1248	1♀	25.0
		2524	1♀	25.0
	20	827	9♀	90.0
		1588	1♀	10.0
	22	620	30♀	100.0
P-6911	1	911	9♀	64.3
		1371	4♀	28.6
		1835	1♀	7.1
	2	844	1♀	100.0
	3	494	20♀	51.3
		1040	15♀	38.5
		1567	3♂♀	7.7
		2072	1♀	2.6
	4	1338	1♀	100.0

TABLE 47 (continued)

Vertical distribution of Aegisthus aculeatus

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER		PER CENT
	5	698	2♀		11.8
		996	15♀	imm.	88.2
	6	665	2♀		10.0
		888	6♀		30.0
		1324	12♀		60.0
	7	539	20♀		55.6
		1000	2♀		5.6
		1300	14♀		38.9
	8	995	2♀		25.0
		1548	6♀		75.0
	9	1006	3♀		30.0
		1580	6♀		60.0
		3442	1♀		10.0
	10	975	2♀		13.3
		1500	8♀		53.3
		2032	2♀		13.3
		2118	2♀		13.3
		2660	1♀		6.7
	11	969	9♀		81.8
		2104	1♀		9.1
		3602	1♀		9.1
	13	1036	3♀		60.0
		1601	2♀		40.0
	14	520	2♀		9.5
		785	5♀		23.8
		954	10♀		47.6
		1443	4♀		19.0
	15	970	12♀		92.3
		1424	1♀		7.7
	17	1039	6♀		66.7
		1590	2♀		22.2
		2216	1♀		11.1

TABLE 48

Vertical distribution of Macrosetella gracilis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6606	4	103	300♀	85.7
		285	25♀	7.1
		593	25♀	7.1
	8	0	640♀	38.0
		100	1050♀	61.4
		2000	10♂♀	0.6
	11	1000	5♀	71.4
		2500	2♀	28.6
	12	0	100♀	28.4
		100	250♀	71.0
		1000	2♀	0.6
	13	100	50♀	100.0
	14	10	100♀	33.3
		100	200♀	66.7
P-6701	1	0	30♀	66.7
		530	15♂♀	33.3
	2	0	10♀	2.3
		90	360♂♀	83.5
		350	60♂♀	13.9
		575	1♀	0.2
	3	0	30♂♀	17.6
		115	35♀	20.6
		250	40♂♀	23.5
		350	60♂♀	35.3
		750	1♀	0.6
		970	4♀	2.4
	4	0	15♀	25.4
		505	44♂♀	74.6
	5	0	100♀	58.1
		90	50♀	29.1
		250	20♂♀	11.6
		1000	1♀	0.6
		1830	1♀	0.6
	8	0	100♀	70.9
		250	40♀	28.4
		955	1♂	0.7

TABLE 48 (continued)

Vertical distribution of <u>Macrosetella gracilis</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER		PER CENT
	10	0	3♀		0.5
		110	400♂♀		73.0
		500	1♂		0.2
		1000	40♀		7.3
		1800	50♂♀		9.1
		2200	12♂♀		2.2
		2850	42♂♀		7.7
	11	110	50♂		73.5
		500	10♂		14.7
		975	2♀		2.9
		1525	2♂♀		2.9
		1800	1♀		1.5
		2375	3♀		4.4
	12	0	180♂♀		40.7
		100	250♂♀		56.6
		1450	7♂♀		1.6
		1825	2♀		0.5
		2450	2♀		0.5
		3200	1♀		0.2
	13	0	1050♂♀		80.5
		100	250♀		19.2
		3100	4♀		0.3
		3200	1♀		0.1
	14	0	800♂♀	imm.	71.5
		100	300♂♀		26.8
		500	6♂♀		0.5
		1000	2♂♀		0.2
		1650	2♂♀		0.2
		2150	4♂♀		0.4
		4350	4♀		0.4
	16	0	480♂♀	imm.	84.8
		100	60♀		10.6
		398	6♀		1.1
		775	4♂♀		0.7
		1250	16♀		2.8
	18	0	1850♂♀		93.8
		100	100♀		5.1

TABLE 48 (continued)

Vertical distribution of <u>Macrosetella gracilis</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1000	6 ♂♀	0.3
		1625	2 ♂♀	0.1
		2200	2 ♀	0.1
		2650	2 ♂♀	0.1
		3800	2 ♀	0.1
		4350	8 ♂♀	0.4
	20	100	1 ♀	0.1
		250	810 ♂♀	99.4
		850	4 ♀	0.5
	22	100	60 ♀	48.8
		475	60 ♀	48.8
		1650	1 ♂	0.8
		2000	1 ♀	0.8
		2350	1 ♂	0.8
	24	0	150 ♂♀	42.6
		100	200 ♀	56.8
		1000	1 ♀	0.3
		3000	1 ♀	0.3
G-6722	4	55	150 ♀	96.8
		335	5 ♀	3.2
	9	0	1750 ♂♀	88.2
		40	200 ♂♀	10.1
		155	30 ♀	1.5
		320	5 ♀	0.3
	10	0	150 ♀	72.1
		45	50 ♂♀	24.0
		225	5 ♂	2.4
		405	3 ♂	1.4
	12	0	750 ♀	78.7
		80	200 ♂♀	21.0
		310	2 ♀	0.2
		1150	1 ♀	0.1
	15	132	9 ♀	100.0
	17	0	80 ♀	78.4
		55	20 ♂♀	19.6
		1000	1 ♀	1.0

TABLE 48 (continued)

Vertical distribution of Macrosetella gracilis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		2000	1♀	1.0
P-6803	4	30	100♀	83.3
		100	20♀	16.7
	8	175	30♀	100.0
	11	580	30♀	100.0
	15	0	120♀	48.0
		100	100♂♀	40.0
		200	20♀	8.0
		400	10♀	4.0
	16	0	80♀	79.2
		100	20♀	19.8
		225	1♀	1.0
	17	100	20♂♀	66.7
		240	10♀	33.3
	18	0	30♀	37.5
		100	40♀	50.0
		480	10♀	12.5
	20	75	40♀	26.7
		125	60♀	40.0
		235	50♀	33.3
	22	100	100♀	60.6
		200	60♀	36.4
		1650	4♀	2.4
		3000	1♀	0.6
	26	100	40♀	100.0
P-6805	2	250	20♀	100.0
	3	0	400♀	76.9
		100	50♀	9.6
		250	60♀	11.5
		1040	10♀	1.9
	4	90	300♀	99.7
		1500	1♀	0.3
	5	0	200♀	52.6
		340	180♀	47.4
	7	0	100♀	3.8

TABLE 48 (continued)

Vertical distribution of Macrosetella gracilis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER		PER CENT
		50	2500 ♂♀		95.9
		500	5 ♀		0.2
		2650	2 ♀		0.1
	9	65	300 ♀		52.6
		250	270 ♀		47.4
	10	55	150 ♀		11.2
		245	1150 ♀		85.8
		477	40 ♀		3.0
		1500	1 ♀		0.1
	11	250	150 ♀		98.0
		2550	3 ♀		2.0
P-6811	1	38	650 ♂♀		91.5
		250	60 ♀		8.5
	2	0	10 ♂		0.6
		77	500 ♂♀		32.1
		237	1050 ♂♀		67.3
	3	0	200 ♀	imm.	68.5
		225	90 ♀		30.8
		1800	2 ♀		0.7
	4	0	8450 ♂♀	imm.	67.7
		50	3600 ♂♀		28.9
		270	420 ♀		3.4
		2150	1 ♀		0.0
		2312	1 ♀		0.0
		3000	6 ♀		0.0
	5	0	1000 ♂♀	imm.	16.6
		25	5000 ♂♀	imm.	83.2
		750	2 ♀		0.0
		1016	1 ♀		0.0
		2450	1 ♀		0.0
		2850	8 ♂♀		0.1
	6	0	1400 ♀	imm.	62.1
		25	850 ♂♀	imm.	37.7
		1000	1 ♀		0.0
		1750	2 ♂♀		0.1
		2525	1 ♀		0.0

TABLE 48 (continued)

Vertical distribution of *Macrosetella gracilis*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER		PER CENT
	7	0	540 ♀	imm.	84.4
		90	40 ♀		6.2
		125	60 ♀		9.4
	8	0	240 ♂♀	imm.	91.3
		27	20 ♀		7.6
		2450	3 ♂♀		1.1
	9	50	300 ♂♀		98.4
		1525	5 ♀		1.6
	10	0	500 ♀	imm.	21.2
		25	1850 ♂♀		78.6
		750	1 ♀		0.0
		1000	4 ♀		0.2
	11	0	1900 ♂♀	imm.	82.6
		45	400 ♂♀		17.4
	12	0	550 ♂♀		15.3
		35	2950 ♂♀		81.9
		160	30 ♀		0.8
		290	70 ♀		1.9
		775	4 ♀		0.1
	14	0	600	imm.	83.1
		40	100 ♂♀		13.9
		285	20 ♀		2.8
		1175	1 ♀		0.1
		2850	1 ♀		0.1
	15	0	350 ♂♀		94.1
		55	20 ♀		5.4
		1950	2 ♀		0.5
	16	52	250 ♀		75.1
		250	80 ♂		24.0
		500	2 ♂		0.6
		2150	1 ♂		0.3
	17	85	100 ♀		97.1
		1500	2 ♂♀		1.9
		2375	1 ♀		1.0
	18	0	50 ♀		100.0
	19	0	800 ♂♀		98.3
		75	6 ♂♀		0.7
		800	4 ♂♀		0.5

TABLE 48 (continued)

Vertical distribution of <u>Macrosetella gracilis</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER		PER CENT
		1250	4 ♂♀		0.5
	20	0	240 ♂♀	imm.	44.3
		75	300 ♂♀	imm.	55.4
		250	2 ♀		0.4
P-6904	1	0	1650 ♀	imm.	80.4
		38	400 ♀		19.5
		215	2 ♀	imm.	0.1
	2	0	200 ♀	imm.	52.6
		14	100 ♀		26.3
		265	80 ♂♀		21.1
	3	0	400 ♀	imm.	10.6
		30	3300 ♂♀	imm.	87.8
		265	60 ♀		1.6
	4	0	90 ♀	imm.	43.9
		30	90 ♀	imm.	43.9
		470	25 ♀		12.2
	5	21	450 ♂♀	imm.	99.3
		2000	2 ♀		0.4
		2620	1 ♀		0.2
	6	0	50 ♀		32.1
		232	100 ♀		64.1
		418	3 ♀		1.9
		1000	2 ♀		1.3
		3594	1 ♀		0.6
	7	25	50 ♀		71.4
		452	20 ♀		28.6
	9	236	30 ♀		25.0
		467	90 ♂♀		75.0
	10	30	120 ♂♀		89.6
		233	10 ♀		7.5
		2394	4 ♀		3.0
	11	45	20 ♂♀		50.0
		262	20 ♀		50.0
	12	0	30 imm.		2.4
		30	1200 ♂♀	imm.	97.6
	13	48	100 imm.		83.3

TABLE 48 (continued)

Vertical distribution of Macrosetella gracilis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		258	10♀	8.3
		524	8♀	6.7
		2115	1♀	0.8
		3474	1♂	0.8
	14	0	30 imm.	100.0
	15	0	10♀	8.9
		52	100♂♀	89.3
		1057	2♀	1.8
	16	1500	1♀	100.0
	17	1408	1♀	100.0
	18	62	20♀	87.0
		1033	2♀	8.7
		1747	1♀	4.3
	21	50	50♀	100.0
	22	252	60♀	100.0
P-6911	1	0	30♀	10.7
		250	250♂	89.3
	2	0	100 imm.	58.8
		53	50♀	29.4
		533	20♀	11.8
	3	0	3♀	2.7
		60	50♀	45.5
		274	50♀	45.5
		739	6♂♀	5.5
		2072	1♀	0.9
	4	81	300♂♀	99.7
		1844	1♀	0.3
	5	0	10♂ imm.	0.7
		59	150♀ imm.	10.5
		237	1250♀	87.8
		1878	4♂♀	0.3
		2474	10♀	0.7
	6	0	100♂♀ imm.	13.3
		50	650♂♀	86.4
		240	2♂	0.3
	7	0	16♀ imm.	5.1
		253	300♀	94.9

TABLE 48 (continued)

Vertical distribution of Macrosetella gracilis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	8	60	400 ♂♀	92.0
		243	30 ♀	6.9
		2088	2 ♂	0.5
		3304	1 ♀	0.2
		3942	2 ♂♀	0.5
	9	0	700 ♂♀ imm.	31.1
		60	1450 ♂♀	64.4
		250	100 ♂♀	4.4
		3910	2 ♂	0.1
	10	56	1500 ♂♀	85.7
		227	240 ♀	13.7
		2118	4 ♀	0.2
		2660	3 ♀	0.2
		3176	4 ♂♀	0.2
	11	0	400 ♂♀ imm.	22.0
		58	700 ♂♀	38.5
		234	690 ♀	37.9
		969	6 ♀	0.3
		1570	2 ♀	0.1
		2104	7 ♂♀ imm.	0.4
		2490	5 ♂♀	0.3
		3602	5 ♀	0.3
		4096	4 ♂♀	0.2
	12	0	63 ♀ imm.	3.8
		36	280 ♂♀	16.7
		78	60 ♂♀	3.6
		153	80 ♀	4.8
		200	24 ♂♀	1.4
		258	30 ♀	1.8
		296	480 ♂♀	28.6
		344	580 ♂♀	34.6
		410	80 ♂♀	4.8
	13	0	200 imm.	13.8
		65	1200 ♂♀	82.6
		269	20 ♂	1.4
		1036	23 ♂♀	1.6
		1601	4 ♀	0.3

TABLE 48 (continued)

Vertical distribution of Macrosetella gracilis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		2232	1♀	0.1
		5200	5♂♀	0.3
	14	34	250♂♀ imm.	97.3
		265	1 imm.	0.4
		785	5♀	1.9
		1443	1♀	0.4
	15	0	240♂♀ imm.	29.9
		53	560♂♀	69.7
		2950	1♀	0.1
		6220	2♂♀	0.2
	16	0	270♀	49.0
		51	120♀	21.8
		243	160♂♀	29.0
		1525	1♂	0.2
	17	0	120♂♀ imm.	100.0

TABLE 49

Vertical distribution of *Microsetella rosea*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6606	4	0	1600 ♀	45.1
		103	1900 ♂♀	53.5
		285	50 ♀	1.4
	8	0	4250 ♂♀	85.4
		100	650 ♀	13.1
		500	75 ♀	1.5
	11	0	850 ♀	65.4
		100	400 ♀	30.8
		500	50 ♀	3.8
	12	0	1100 ♂♀	61.1
		100	700 ♀	38.9
		1000	1 ♀	0.1
	13	0	5250 ♂♀	92.1
		100	375 ♀	6.6
		300	75 ♀	1.3
	14	10	1750 ♀	83.3
		100	350 ♀	16.7
P-6701	1	530	25 ♀	96.2
		1250	1 ♀	3.8
	2	90	270 ♀	64.6
		350	140 ♀	33.5
		500	6 ♀	1.4
		575	2 ♀	0.5
	3	115	30 ♀	11.0
		250	180 ♀	66.2
		350	60 ♀	22.1
		435	2 ♀	0.7
	4	1000	2 ♀	100.0
	5	90	1600 ♀	88.8
		250	200 ♀	11.1
		860	2 ♀	0.1
	8	250	320 ♀	75.5
		505	90 ♀	21.2
		817	10 ♀	2.4
		955	3 ♀	0.7
		1625	1 ♀	0.2

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JUN 76 H B MICHEL, M FOYO, D A HAAGENSEN N00014-67-A-0201-0013

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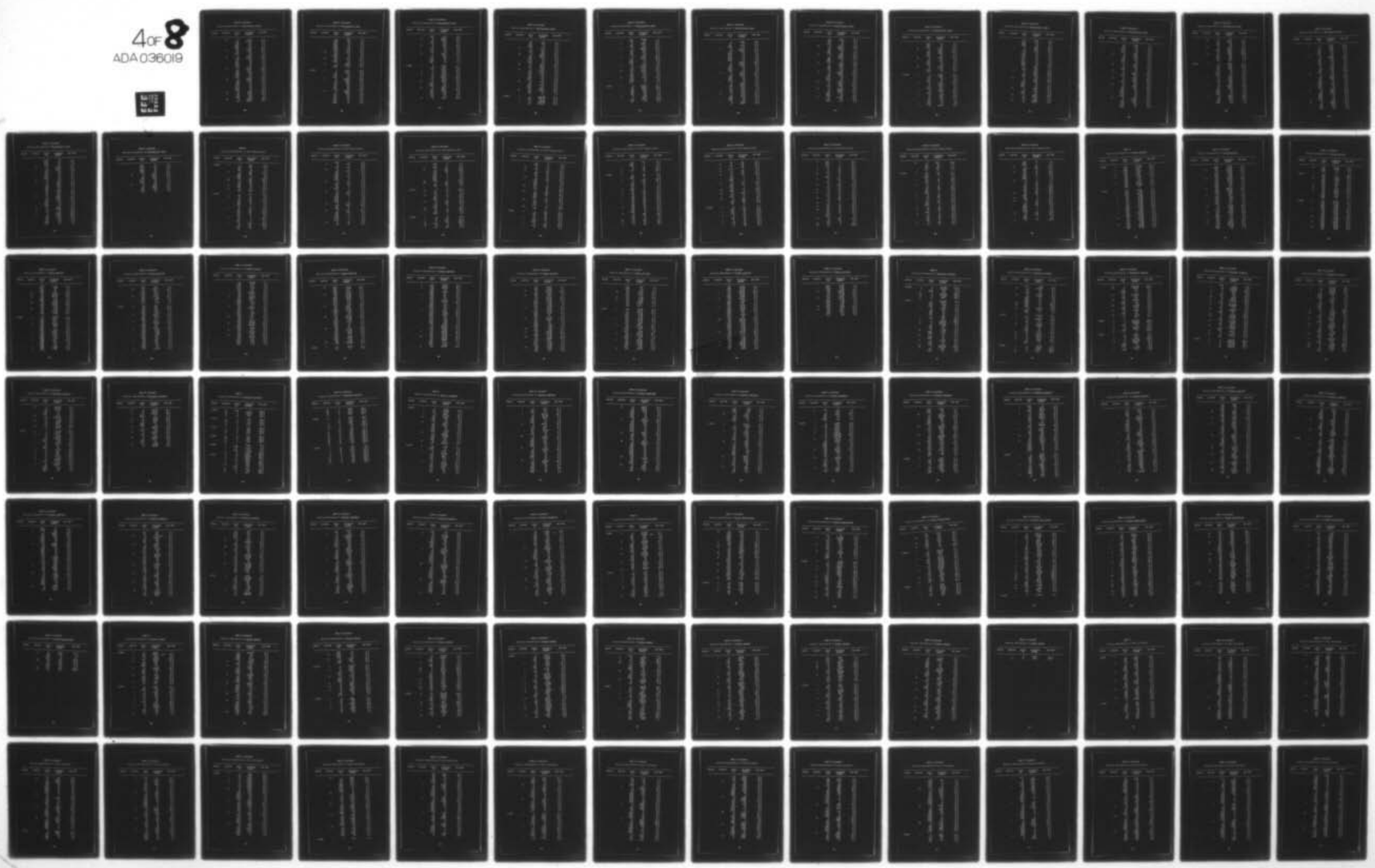

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1.0 1.1 1.25 1.4 1.6 1.8 2.0 2.2 2.5 2.8 3.2 3.6 4.0 4.5 5.0 5.6

TABLE 49 (continued)

Vertical distribution of *Microsetella rosea*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	10	0	24♀	1.1
		110	2000♀	94.8
		500	3♀	0.1
		1000	5♀	0.2
		1800	70♀	3.3
		2200	8♀	0.4
	11	110	1550♀	98.5
		500	10♀	0.6
		1525	2♀	0.1
		2375	12♀	0.8
	12	0	10♀	0.2
		100	4050♀	99.4
		920	2♀	0.0
		1450	3♀	0.1
		1825	3♀	0.1
		2450	2♀	0.0
		3200	4♀	0.1
	13	0	3050♀	59.3
		100	2050♀	39.8
		450	30♀	0.6
		1000	10♀	0.2
		1500	1♀	0.0
		3200	4♀	0.1
	14	0	2050♀	47.2
		100	2250♀	51.8
		500	18♀	0.4
		1650	3♀	0.1
		2150	7♀	0.2
		2375	6♀	0.1
		3850	2♀	0.0
		4350	9♀	0.2
	16	0	690♀	64.3
		100	340♀	31.7
		398	21♀	2.0
		1250	22♀	2.1
	18	0	1250♀	43.4
		100	1500♀	52.1

TABLE 49 (continued)

Vertical distribution of *Microsetella rosea*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		500	80 ♀	2.8
		1000	9 ♀	0.3
		1625	1 ♀	0.0
		2200	9 ♀	0.3
		2650	4 ♀	0.1
		3800	20 ♀	0.7
		4350	8 ♀	0.3
	20	250	180 ♀	97.3
		850	3 ♀	1.6
		1050	1 ♀	0.5
		1500	1 ♀	0.5
	22	100	30 ♀	85.7
		2000	4 ♀	11.4
		2350	1 ♀	2.9
	24	0	300 ♀	17.6
		100	1400 ♀	82.3
		2600	1 ♀	0.1
G-6722	4	0	750 ♀	12.9
		55	5050 ♀	87.0
		581	1 ♀	0.0
		1040	1 ♀	0.0
		1520	3 ♀	0.1
	9	0	29500 ♀	98.4
		40	300 ♀	1.0
		155	80 ♀	0.3
		320	85 ♀	0.3
		562	4 ♀	0.0
		875	8 ♀	0.0
		1200	3 ♀	0.0
	10	0	4000 ♀	93.9
		45	200 ♀	4.7
		225	35 ♀	0.8
		405	9 ♀	0.2
		630	4 ♀	0.1
		824	1 ♀	0.0
		1800	7 ♀	0.2
		3500	1 ♀	0.0

TABLE 49 (continued)

Vertical distribution of <u>Microsetella</u> <u>rosea</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		4500	1♀	0.0
	12	0	2200♀	54.3
		80	1800♀	44.4
		181	30♀	0.7
		310	20♀	0.5
	15	0	60♀	51.3
		30	50♀	42.7
		132	3♀	2.6
		240	3♀	2.6
		450	1♀	0.9
	17	0	1600♀	92.7
		55	80♀	4.6
		250	30♀	1.7
		525	6♀	0.3
		1500	1♀	0.1
		2000	9♀	0.5
P-6803	4	0	160♀	7.9
		30	1750♀	86.2
		100	120♀	5.9
	5	0	1750♀	76.1
		40	550♀	23.9
	8	0	120♀	3.3
		40	1950♀	53.3
		95	1350♀	36.9
		175	240♀	6.6
	11	0	480♀	85.4
		580	30♀	5.3
		1500	4♀	0.7
		2500	48♀	8.5
	15	0	180♀	6.6
		100	2300♀	84.5
		200	160♀	5.9
		400	70♀	2.6
		750	8♀	0.3
		995	4♀	0.1
	16	0	180♀	69.8

TABLE 49 (continued)

Vertical distribution of Microsetella rosea

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		100	60 ♀	23.3
		225	16 ♀	6.2
		1000	1 ♀	0.4
		3000	1 ♀	0.4
	17	0	300 ♀	73.2
		100	70 ♀	17.1
		240	40 ♀	9.8
	18	0	240 ♀	10.7
		100	1680 ♀	75.2
		245	300 ♀	13.4
		1000	6 ♀	0.3
		2150	1 ♀	0.0
		3500	6 ♀	0.3
	20	75	520 ♀	46.8
		125	300 ♀	27.0
		235	290 ♀	26.1
	22	0	90 ♀	1.4
		100	5950 ♀	93.5
		200	270 ♀	4.2
		470	40 ♀	0.6
		890	4 ♀	0.1
		1650	10 ♀	0.2
		3000	3 ♀	0.0
	25	0	80 ♀	22.8
		100	2 ♀	0.6
		250	160 ♀	45.6
		1000	3 ♀	0.9
		1425	106 ♀	30.2
	26	100	2200 ♀	99.5
		150	9 ♀	0.4
		750	2 ♀	0.1
P-6805	2	0	2100 ♂♀	26.1
		100	5900 ♂♀	73.2
		250	60 ♂♀	0.7
	3	0	3900 ♂♀	49.6
		100	3600 ♂♀	45.8

TABLE 49 (continued)

Vertical distribution of Microsetella rosea

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		250	360 ♂♀	4.6
		2250	5 ♀	0.1
	4	0	150 ♀	33.1
		90	300 ♀	66.2
		1500	3 ♀	0.7
	5	0	1600 ♀	82.6
		96	260 ♀	13.4
		340	60 ♀	3.1
		500	14 ♀	0.7
		770	2 ♀	0.1
	7	0	950 ♀	11.6
		50	7200 ♀	88.2
		1500	3 ♀	0.0
		2300	2 ♀	0.0
		2650	6 ♀	0.1
	9	0	150 ♀	5.9
		65	2200 ♀	85.9
		250	210 ♀	8.2
	10	245	1100 ♀	89.4
		477	120 ♀	9.7
		995	10 ♀	0.8
		1500	1 ♀	0.1
	11	250	350 ♀	97.5
		1700	3 ♀	0.8
		2550	5 ♀	1.4
		4517	1 ♀	0.3
P-6811	1	0	1050 ♀	33.1
		38	1350 ♀	42.6
		250	690 ♀	21.8
		500	60 ♀	1.9
		750	5 ♀	0.2
		950	15 ♀	0.5
	2	0	20 ♀	3.2
		77	400 ♀	64.0
		237	200 ♀	32.0
		1200	5 ♀	0.8

TABLE 49 (continued)

Vertical distribution of <u>Microsetella rosea</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	3	0	100♀	29.0
		63	3♀	0.9
		225	240♀	69.6
		1800	2♀	0.6
	4	0	1450♀	9.7
		50	13400♀	89.8
		270	60♀	0.4
		1800	1♀	0.0
		2150	1♀	0.0
		2312	2♀	0.0
		3000	6♀	0.0
		3250	2♀	0.0
	5	0	1900♀	30.9
		25	4100♀	66.6
		250	150♀	2.4
		1016	5♀	0.1
		1823	1♀	0.0
		2850	2♀	0.0
	6	0	650♀	19.4
		25	1850♀	55.3
		250	840♀	25.1
		1000	1♀	0.0
		2025	2♀	0.1
		2525	2♀	0.1
	7	0	90♀	2.7
		90	2680♀	80.7
		125	240♀	7.2
		225	150♀	4.5
		275	140♀	4.2
		500	20♀	0.6
	8	0	210♀	31.4
		27	70♀	10.5
		238	380♀	56.8
		1500	4♀	0.6
		2450	5♀	0.7
	9	0	400♀	26.5
		50	800♀	53.0

TABLE 49 (continued)

Vertical distribution of Microsetella rosea

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		230	300♀	19.9
		450	5♀	0.3
		875	1♀	0.1
		2350	3♀	0.2
	10	0	2800♀	39.1
		25	4050♀	56.6
		250	250♀	3.5
		900	1♀	0.0
		1000	52♀	0.7
	11	0	850♀	29.8
		45	1650♀	57.8
		285	350♀	12.3
		1200	2♀	0.1
		1400	4♀	0.1
	12	0	350♀	38.3
		35	400♀	43.8
		160	70♀	7.7
		290	90♀	9.9
		550	3♀	0.3
	14	0	2650♀	68.2
		40	1100♀	28.3
		285	120♀	3.1
		1175	1♀	0.0
		2375	2♀	0.1
		2850	15♀	0.4
	15	0	1650♀	70.7
		55	320♀	13.7
		237	360♀	15.4
		470	5♀	0.2
	16	0	2350♀	43.3
		52	2850♀	52.5
		250	220♀	4.1
		1000	4♀	0.1
		2550	2♀	0.0
	17	85	5550♀	99.7
		714	2♀	0.0
		1000	10♀	0.2

TABLE 49 (continued)

Vertical distribution of Microsetella rosea

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1500	2♀	0.0
		1950	1♀	0.0
		3500	2♀	0.0
	18	0	1100♀	64.7
		114	400♀	23.5
		260	180♀	10.6
		525	20♀	1.2
		1500	1♀	0.1
	19	0	950♀	95.5
		75	13♀	1.3
		320	30♀	3.0
		1500	1♀	0.1
		1850	1♀	0.1
	20	0	30♀	1.3
		75	2350♀	98.4
		250	2♀	0.1
		1000	5♀	0.2
P-6904	1	0	4250♀	93.2
		38	300♀	6.6
		215	6♀	0.1
		795	2♀	0.0
		1125	1♀	0.0
	2	0	1250♀	83.3
		14	100♀	6.7
		265	140♀	9.3
		1150	10♀	0.7
	3	0	100♀	12.5
		30	700♀	87.4
		800	1♀	0.1
	4	0	90♀	20.5
		30	240♀	54.8
		230	75♀	17.1
		470	25♀	5.7
		950	4♀	0.9
		3560	4♀	0.9
	5	21	1050♀	83.2

TABLE 49 (continued)

Vertical distribution of Microsetella rosea

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		250	200♀	15.8
		1033	10♀	0.8
		2000	1♀	0.1
		2620	1♀	0.1
	6	0	200♀	18.2
		31	120♀	10.9
		232	750♀	68.3
		418	5♀	0.5
		1000	3♀	0.3
		1500	2♀	0.2
		2575	1♀	0.1
		3144	9♀	0.8
		3594	4♀	0.4
		4000	2♀	0.2
		6000	2♀	0.2
	7	241	140♀	87.5
		452	10♀	6.2
		918	10♀	6.2
	9	0	130♀	16.5
		70	300♀	38.0
		236	330♀	41.8
		467	30♀	3.8
	10	0	8♀	2.8
		30	240♀	83.6
		233	30♀	10.5
		1484	5♀	1.7
		1892	2♀	0.7
		2394	2♀	0.7
	11	0	200♀	86.2
		45	10♀	4.3
		262	20♀	8.6
		1036	2♀	0.9
	12	0	1300♀	60.8
		30	850♀	37.4
		259	40♀	1.8
	13	0	1650♀	53.0
		48	1350♀	43.4

TABLE 49 (continued)

Vertical distribution of <u>Microsetella rosea</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		2[illegible]8	100♀	3.2
		753	6♀	0.2
		1019	2♀	0.1
		1638	1♀	0.0
		2612	2♀	0.1
	14	0	185♀	31.4
		37	20♀	3.4
		239	360♀	61.1
		458	20♀	3.4
		1052	2♀	0.3
		2336	2♀	0.3
	15	0	10♀	2.4
		52	350♀	85.4
		261	48♀	11.7
		2248	2♀	0.5
	16	0	8♀	0.4
		59	1520♀	83.9
		253	280♀	15.5
		519	4♀	0.2
	17	0	190♀	32.0
		45	220♀	37.1
		251	180♀	30.4
		971	3♀	0.5
	18	0	30♀	5.4
		62	420♀	76.2
		261	90♀	16.3
		802	5♀	0.9
		1033	2♀	0.4
		1532	1♀	0.2
		1747	1♀	0.2
		1942	2♀	0.4
	19	0	10♀	0.5
		30	1950♀	93.2
		274	120♀	5.7
		550	10♀	0.5
		1248	1♀	0.0
		1986	1♀	0.0

TABLE 49 (continued)

Vertical distribution of *Microsetella rosea*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	20	0	70♀	2.9
		10	2350♀	96.7
		258	6♀	0.2
		537	3♀	0.1
	21	0	15♀	1.2
		50	150♀	12.1
		220	850♀	68.8
		297	220♀	17.8
	22	40	950♀	88.8
		252	30♀	2.8
		372	10♀	0.9
		450	60♀	5.6
		554	20♀	1.9
P-6911	1	0	390♀	23.4
		65	750♀	45.0
		250	450♀	27.0
		459	60♀	3.6
		715	3♀	0.2
		911	3♀	0.2
		1371	4♀	0.2
		1835	5♀	0.3
	2	0	700♀	57.9
		53	40♀	3.3
		242	450♀	37.2
		533	20♀	1.7
	3	0	16♀	0.6
		60	2550♀	95.0
		274	100♀	3.7
		739	12♀	0.4
		1567	3♀	0.1
		2072	1♀	0.0
		2556	3♀	0.1
	4	0	200♀	16.5
		81	950♀	78.5
		218	40♀	3.3
		1338	6♀	0.5
		1844	14♀	1.2

TABLE 49 (continued)

Vertical distribution of <u>Microsetella</u> <u>rosea</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	5	0	135 ♀	22.8
		59	330 ♀	55.6
		237	100 ♀	16.9
		472	20 ♀	3.4
		698	2 ♀	0.3
		1878	6 ♀	1.0
	6	0	60 ♀	5.3
		50	1000 ♀	88.8
		240	2 ♀	0.2
		481	60 ♀	5.3
		665	2 ♀	0.2
		888	2 ♀	0.2
	7	0	12 ♀	5.9
		60	60 ♀	29.4
		253	90 ♀	44.1
		539	40 ♀	19.6
		1000	2 ♀	1.0
	8	0	2 ♀	0.3
		60	350 ♀	55.2
		243	240 ♀	37.9
		510	20 ♀	3.2
		995	2 ♀	0.3
		2088	6 ♀	0.9
		2316	10 ♀	1.6
		3304	1 ♀	0.2
		3942	3 ♀	0.5
	9	0	500 ♀	39.7
		60	350 ♀	27.8
		250	400 ♀	31.8
		1580	3 ♀	0.2
		2088	3 ♀	0.2
		3442	1 ♀	0.1
		3910	2 ♀	0.2
	10	0	150 ♀	12.3
		56	1000 ♀	81.7
		227	40 ♀	3.3
		480	20 ♀	1.6
		975	2 ♀	0.2

TABLE 49 (continued)

Vertical distribution of Microsetella rosea

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		2032	1♀	0.1
		2118	4♀	0.3
		2660	5♀	0.4
		3176	2♀	0.2
	11	0	300♀	11.7
		58	2100♀	81.6
		234	150♀	5.8
		969	3♀	0.1
		1570	6♀	0.2
		2104	2♀	0.1
		3602	4♀	0.2
		4096	8♀	0.3
	12	0	36♀	2.7
		36	80♀	6.0
		78	840♀	63.3
		153	40♀	3.0
		200	20♀	1.5
		258	21♀	1.6
		296	120♀	9.0
		344	140♀	10.6
		465	30♀	2.3
	13	0	100♀	4.4
		65	1950♀	85.1
		269	200♀	8.7
		500	20♀	0.9
		2232	2♀	0.1
		2862	3♀	0.1
		5200	17♀	0.7
	14	0	240♀	4.8
		34	4750♀	95.2
		265	2♀	0.0
	15	0	1110♀	50.1
		53	640♀	28.9
		224	420♀	19.0
		445	10♀	0.5
		970	16♀	0.7
		1424	1♀	0.0
		2950	2♀	0.1

TABLE 49 (continued)

Vertical distribution of *Microsetella rosea*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		3932	1♀	0.0
		4556	1♀	0.0
		6220	3♀	0.1
		7000	3♀	0.1
		7500	8♀	0.4
	16	0	390♀	13.1
		51	2240♀	75.0
		243	320♀	10.7
		478	30♀	1.0
		1012	3♀	0.1
		1525	2♀	0.1
	17	0	20♀	1.8
		54	600♀	53.9
		261	480♀	43.1
		514	10♀	0.9
		1039	3♀	0.3

TABLE 50

Vertical distribution of other Harpacticoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6606	4	0	200	46.0
		103	200	46.0
		593	25	5.7
		700	10	2.3
	8	0	500	60.2
		100	300	36.1
		1000	25	3.0
		2000	5	0.6
	11	100	100	100.0
	12	0	250	66.7
		100	100	26.7
		300	25	6.7
	13	100	25	55.6
		500	20	44.4
	14	10	50	14.3
		100	300	85.7
P-6701	1	0	410	98.8
		530	5	1.2
	2	0	10	3.5
		90	210	72.7
		220	40	13.8
		350	20	6.9
		500	6	2.1
		575	3	1.0
	3	0	10	5.0
		115	50	24.9
		250	100	49.8
		350	30	14.9
		435	10	5.0
		750	1	0.5
	4	0	5	35.7
		505	8	57.1
		1338	1	7.1
	5	0	250	58.0
		90	150	34.8
		250	20	4.6
		504	10	2.3

TABLE 50 (continued)

Vertical distribution of other Harpacticoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1830	1	0.2
	8	0	200	58.3
		70	3	0.9
		250	140	40.8
	10	0	3	0.3
		110	1100	95.0
		500	4	0.3
		1000	25	2.2
		1800	10	0.9
		2200	4	0.3
		2850	12	1.0
	11	0	4	0.4
		110	980	97.9
		500	10	1.0
		975	2	0.2
		1525	2	0.2
		2375	3	0.3
	12	0	30	1.5
		100	1950	97.3
		500	20	1.0
		1450	1	0.0
		1825	1	0.0
		3100	1	0.0
		3200	1	0.0
	13	0	250	14.9
		100	1400	83.3
		450	30	1.8
		3200	1	0.1
	14	0	150	21.1
		100	500	70.3
		500	44	6.2
		1650	1	0.1
		2150	11	1.5
		2375	1	0.1
		4350	4	0.6
	16	0	30	22.4
		100	60	44.8

TABLE 50 (continued)

Vertical distribution of other Harpacticoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		398	6	4.5
		775	1	0.7
		1250	37	27.6
	18	0	450	38.1
		100	600	50.8
		500	120	10.2
		1625	3	0.3
		2200	2	0.2
		2650	3	0.3
		3800	2	0.2
	20	850	3	100.0
	24	0	200	16.8
		100	950	79.8
		500	40	3.4
G-6722	4	0	50	100.0
	9	155	20	95.2
		875	1	4.8
	10	45	10	41.7
		405	6	25.0
		630	4	16.7
		1800	4	16.7
	12	0	150	25.8
		80	400	68.8
		181	30	5.2
		1150	1	0.2
	15	132	3	100.0
	17	55	10	30.3
		250	20	60.6
		1000	3	9.1
P-6803	4	0	20	28.6
		30	50	71.4
	5	40	1250	100.0
	8	0	400	100.0
	11	2500	8	100.0
	15	0	80	21.5
		100	250	67.2

TABLE 50 (continued)

Vertical distribution of other Harpacticoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		400	40	10.8
		995	2	0.5
	16	0	60	90.9
		420	6	9.1
	17	0	100	62.5
		100	20	12.5
		240	20	12.5
		490	20	12.5
	18	0	30	17.3
		100	120	69.4
		480	20	11.6
		1500	1	0.6
		3500	2	1.2
	20	125	40	57.1
		235	10	14.3
		475	20	28.6
	22	0	20	8.2
		100	100	41.2
		200	120	49.4
		890	2	0.8
		1650	1	0.4
	25	0	360	89.1
		500	40	9.9
		750	2	0.5
		1425	2	0.5
	26	0	8	28.6
		480	20	71.4
P-6805	2	0	100	29.4
		100	200	58.8
		250	40	11.8
	3	0	50	22.5
		100	150	67.6
		250	20	9.0
		2400	2	0.9
	4	0	150	60.0
		500	100	40.0
	7	0	50	6.6

TABLE 50 (continued)

Vertical distribution of other Harpacticoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		50	700	93.0
		2300	1	0.1
		2650	2	0.3
	9	0	100	66.7
		65	50	33.3
	11	537	20	100.0
P-6811	1	0	500	96.0
		500	20	3.8
		2025	1	0.2
	2	77	50	100.0
	3	0	2300	97.3
		225	30	1.3
		500	30	1.3
		770	4	0.2
	4	550	80	97.6
		3000	2	2.4
	5	25	200	83.3
		500	40	16.7
	6	25	50	33.3
		250	40	26.7
		485	60	40.0
	7	90	80	17.4
		125	300	65.2
		375	60	13.0
		500	20	4.3
	8	238	20	28.6
		480	40	57.1
		713	8	11.4
		2000	2	2.9
	9	0	100	10.3
		50	850	87.2
		450	5	0.5
		635	20	2.1
	10	25	100	66.7
		250	50	33.3
	11	0	150	75.0

TABLE 50 (continued)

Vertical distribution of other Harpacticoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		45	50	25.0
	12	35	100	83.3
		160	20	16.7
	14	0	100	99.0
		2375	1	1.0
	15	0	100	62.5
		237	60	37.5
	16	0	100	87.0
		500	4	3.5
		750	5	4.3
		1000	4	3.5
		1500	2	1.7
	17	0	210	83.0
		485	40	15.8
		1500	1	0.4
		2375	2	0.8
	18	260	30	88.2
		1050	4	11.8
	19	0	1050	97.1
		320	30	2.8
		2350	1	0.1
	20	0	210	39.6
		75	200	37.7
		500	100	18.9
		750	20	3.8
P-6904	1	0	550	79.7
		415	10	1.4
		1450	130	18.8
	2	500	30	75.0
		1150	10	25.0
	3	0	150	65.2
		30	50	21.7
		265	30	13.0
	4	0	60	54.5
		230	50	45.5
	5	0	570	91.9
		21	50	8.1

TABLE 50 (continued)

Vertical distribution of other Harpacticoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	6	1500	4	66.7
		3144	1	16.7
		3594	1	16.7
	7	25	50	83.3
		737	10	16.7
	9	0	10	25.0
		236	30	75.0
	10	0	15	50.0
		455	10	33.3
		1665	5	16.7
	11	0	650	90.3
		45	50	6.9
		524	20	2.8
	12	0	120	31.6
		30	250	65.8
		515	10	2.6
	13	0	150	93.7
		258	10	6.2
	14	0	25	26.3
		239	60	63.2
		458	10	10.5
	15	0	100	48.5
		52	100	48.5
		261	6	2.9
	16	0	2	9.1
		253	20	90.9
	17	251	20	66.7
		750	10	33.3
	18	261	90	47.4
		531	40	21.1
		802	55	28.9
		1033	2	1.1
		2540	3	1.6
	19	0	210	65.6
		30	100	31.2
		550	10	3.1
	20	537	9	100.0
	21	490	3	100.0

TABLE 50 (continued)

Vertical distribution of other Harpacticoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	22	0	1440	80.4
		40	50	2.8
		372	20	1.1
		450	120	6.7
		554	160	8.9
P-6911	1	250	250	91.9
		459	20	7.4
		1835	1	0.4
		2337	1	0.4
	2	242	30	58.8
		533	20	39.2
		844	1	2.0
	3	0	6	4.4
		60	50	36.2
		274	50	36.2
		494	30	21.8
		1567	1	0.7
		2556	1	0.7
	4	0	20	16.7
		423	100	83.3
	5	0	5	2.1
		237	50	20.8
		472	180	75.0
		1878	4	1.7
		2474	1	0.4
	6	0	40	40.0
		481	60	60.0
	7	0	16	94.1
		1000	1	5.9
	8	0	12	10.6
		60	50	44.2
		243	30	26.5
		510	20	17.7
		995	1	0.9
	9	0	200	76.3
		60	50	19.1

TABLE 50 (continued)

Vertical distribution of other Harpacticoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		515	10	3.8
		2088	1	0.4
		2454	1	0.4
	10	0	100	54.3
		480	80	43.5
		2118	4	2.2
	11	234	30	60.0
		491	15	30.0
		2104	2	4.0
		2490	2	4.0
		3602	1	2.0
	12	0	3	1.4
		36	10	4.7
		78	20	9.4
		153	40	18.8
		296	40	18.8
		410	40	18.8
		465	60	28.2
	13	65	100	82.0
		500	20	16.4
		1601	2	1.6
	14	265	1	33.3
		520	2	67.7
	15	0	30	11.7
		53	40	15.6
		224	180	70.0
		2950	3	1.2
		3932	1	0.4
		4556	1	0.4
		6220	2	0.8
	16	51	160	56.7
		243	120	42.6
		1012	1	0.4
		1525	1	0.4
	17	514	10	100.0

TABLE 51

Vertical distribution of <u>Conaea gracilis</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6606	4	700	150 ♂♀	88.2
		1000	20 ♂♀	11.8
	8	1000	225 ♀	92.2
		3250	19 ♂♀	7.8
	11	500	200 ♀	88.9
		2000	25 ♀	11.1
	12	300	225 ♂♀	79.8
		500	6 ♀	2.1
		1000	6 ♂♀	2.1
		1500	45 ♀	16.0
	13	500	380 ♂♀	72.2
		1000	145 ♂♀	27.6
		1300	1 ♀	0.2
P-6701	1	845	104 ♂♀	48.1
		1250	2 ♂♀	0.9
		1725	105 ♂♀	48.6
		2425	5 ♂♀	2.3
	2	350	40 ♂♀	57.1
		500	16 ♂♀	22.9
		575	14 ♂♀	20.0
	3	435	46 ♂♀	25.4
		750	79 ♂♀	43.6
		970	56 ♂♀	30.9
	4	1000	60 ♂♀	80.0
		1338	13 ♂♀	17.3
		2500	2 ♂♀	2.7
	5	504	180 ♂♀	53.9
		860	138 ♂♀	41.3
		1000	16 ♂♀	4.8
	8	505	160 ♂♀	42.9
		817	155 ♂♀	41.6
		955	52 ♂♀	13.9
		1625	6 ♂♀	1.6
	10	500	99 ♂♀	24.6
		1000	145 ♂♀	36.1
		1800	55 ♂♀	13.7

TABLE 51 (continued)

Vertical distribution of <u>Conaea gracilis</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		2200	34 ♂♀	8.5
		2850	69 ♂♀	17.2
	11	500	460 ♂♀	72.4
		975	108 ♂♀	17.0
		1525	6 ♂♀	0.9
		1800	10 ♂♀	1.6
		2375	51 ♂♀	8.0
	12	500	300 ♂♀	82.9
		920	36 ♂♀	9.9
		1450	16 ♂♀	4.4
		1825	2 ♂♀	0.6
		2450	7 ♂♀	1.9
		3200	1 ♂	0.3
	13	450	1080 ♂♀	78.7
		1000	270 ♂♀	19.7
		1500	19 ♂♀	1.4
		3200	3 ♂♀	0.2
	14	0	50 ♀	79.4
		1000	7 ♂♀	11.1
		1650	2 ♂♀	3.2
		2150	2 ♂♀	3.2
		2375	1 ♀	1.6
		4350	1 ♀	1.6
	16	0	30 ♂♀	19.1
		398	93 ♂♀	59.2
		775	27 ♂♀	17.2
		1250	7 ♂♀	4.5
	18	500	480 ♂♀	98.6
		1625	2 ♂♀	0.4
		2200	1 ♀	0.2
		2650	4 ♂♀	0.8
	20	100	1 ♂	3.3
		1050	29 ♂♀	96.7
	22	475	120 ♂♀	37.7
		1000	180 ♂♀	56.6
		1650	16 ♂♀	5.0
		2000	2 ♂♀	0.6

TABLE 51 (continued)

Vertical distribution of <u>Conaea gracilis</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	24	500	140 ♂♀	85.4
		1000	23 ♂♀	14.0
		3000	1 ♂	0.6
G-6722	4	581	2 ♀	50.0
		1040	2 ♂	50.0
	10	405	15 ♂♀	21.4
		630	46 ♂♀	65.7
		824	8 ♂♀	11.4
		1800	1 ♂	1.4
	12	675	54 ♂♀	96.4
		1150	2 ♀	3.6
	15	450	3 ♀	12.0
		635	22 ♂♀	88.0
	17	250	30 ♂♀	33.3
		525	39 ♂♀	43.3
		1000	4 ♀	4.4
		1500	15 ♂♀	16.7
		2000	2 ♀	2.2
P-6803	11	580	630 ♂♀	84.2
		1030	42 ♂♀	5.6
		1500	52 ♂♀	7.0
		2000	8 ♂♀	1.1
		2500	16 ♂♀	2.1
	15	400	110 ♂♀	53.4
		750	75 ♂♀	36.4
		995	19 ♂♀	9.2
		1200	2 ♂♀	1.0
	16	420	48 ♂♀	30.8
		1000	104 ♂♀	66.7
		1500	4 ♂♀	2.6
	17	490	460 ♂♀	85.0
		1000	66 ♂♀	12.2
		2200	15 ♂♀	2.8
	18	480	80 ♂♀	40.4
		1000	87 ♂♀	43.9

TABLE 51 (continued)

Vertical distribution of <u>Conaea gracilis</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1500	24 ♂♀	12.1
		2150	3 ♂♀	1.5
		2200	3 ♀	1.5
		3500	1 ♂	0.5
	20	475	130 ♂♀	40.8
		740	189 ♂♀	59.2
	22	890	182 ♂♀	95.3
		1650	4 ♀	2.1
		3000	5 ♂♀	2.6
	25	500	130 ♂♀	41.1
		750	60 ♂♀	19.0
		1000	120 ♂♀	38.0
		1425	6 ♂♀	1.9
	26	150	7 ♂♀	2.2
		480	220 ♂♀	70.1
		750	52 ♂♀	16.6
		1000	35 ♂♀	11.1
P-6805	2	440	40 ♂♀	11.3
		715	280 ♂♀	78.9
		1000	20 ♀	5.6
		1500	15 ♀	4.2
	3	500	330 ♂♀	76.7
		1040	40 ♂♀	9.3
		1583	3 ♀	0.7
		2250	1 ♀	0.2
		2400	56 ♂♀	13.0
	4	500	100 ♀	25.5
		1010	110 ♂♀	28.1
		1500	7 ♀	1.8
		2000	175 ♂♀	44.6
	7	500	5 ♀	6.0
		1000	70 ♀	83.3
		1500	1 ♀	1.2
		2300	4 ♀	4.8
		2650	4 ♀	4.8
	9	500	520 ♂♀	94.4
		1438	3 ♀	0.5

TABLE 51 (continued)

Vertical distribution of Conaea gracilis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		2026	28 ♀	5.1
	10	477	560 ♀	78.0
		995	130 ♀	18.1
		1500	12 ♀	1.7
		2256	16 ♂♀	2.2
	11	1050	140 ♀	41.2
		1700	177 ♂♀	52.1
		2263	13 ♂♀	3.8
		2550	4 ♀	1.2
		4517	6 ♂♀	1.8
P-6811	1	500	80 ♀	43.7
		750	60 ♀	32.8
		950	20 ♀	10.9
		1380	10 ♀	5.5
		2025	13 ♂♀	7.1
	2	508	320 ♀	27.3
		822	760 ♂♀	64.8
		1000	92 ♀	7.8
		1200	1 ♀	0.1
	3	500	100 ♀	36.1
		770	156 ♂♀	56.3
		1450	18 ♀	6.5
		1800	3 ♀	1.1
	4	550	600 ♀	85.0
		1050	45 ♂♀	6.4
		1800	20 ♂♀	2.8
		2150	3 ♂♀	0.4
		2312	16 ♂♀	2.3
		3000	14 ♀	2.0
		3250	8 ♀	1.1
	5	500	80 ♀	74.1
		750	10 ♀	9.3
		1823	10 ♀	9.3
		2450	4 ♀	3.7
		2850	4 ♀	3.7
	6	485	690 ♂♀	42.3

TABLE 51 (continued)

Vertical distribution of Conaea gracilis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		720	870 ♂♀	53.4
		1000	16 ♂♀	1.0
		1750	13 ♀	0.8
		2025	37 ♂♀	2.3
		2525	4 ♀	0.2
	7	275	40 ♀	2.3
		375	1660 ♂♀	93.8
		500	70 ♀	4.0
	8	480	530 ♂♀	36.5
		713	368 ♂♀	25.3
		1000	470 ♀	32.3
		1500	64 ♀	4.4
		2000	21 ♂♀	1.4
		2450	1 ♀	0.1
	9	450	35 ♀	2.2
		635	1520 ♂♀	93.8
		875	2 ♀	0.1
		1400	7 ♀	0.4
		1525	55 ♂♀	3.4
		2350	1 ♀	0.1
	10	500	150 ♀	43.5
		750	4 ♀	1.2
		900	11 ♀	3.2
		1000	180 ♂♀	52.2
	11	590	325 ♂♀	61.3
		800	120 ♂♀	22.6
		1200	5 ♀	0.9
		1400	80 ♂♀	15.1
	12	550	21 ♀	8.9
		775	184 ♂♀	77.6
		1100	32 ♂♀	13.5
	14	590	80 ♀	22.8
		800	230 ♂♀	65.5
		1175	2 ♂	0.6
		1700	36 ♂♀	10.3
		1875	1 ♀	0.3
		2850	2 ♂♀	0.6

TABLE 51 (continued)

Vertical distribution of Conaea gracilis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	15	1000	52 ♂♀	32.5
		1325	42 ♂♀	26.2
		1500	12 ♀	7.5
		1950	54 ♂♀	33.7
	16	500	36 ♂♀	9.1
		750	225 ♂♀	57.0
		1000	90 ♂♀	22.8
		1500	28 ♂♀	7.1
		1875	1 ♀	0.3
		2150	11 ♂♀	2.8
		2550	4 ♀	1.0
	17	484	320 ♂♀	38.0
		714	20 ♀	2.4
		1000	450 ♂♀	53.4
		1500	44 ♂♀	5.2
		1950	7 ♂♀	0.8
		2375	2 ♀	0.2
	18	525	360 ♂♀	48.4
		763	312 ♂♀	41.9
		1050	56 ♂♀	7.5
		1500	11 ♂♀	1.5
		1900	3 ♀	0.4
		2500	1 ♀	0.1
		3500	1 ♀	0.1
	19	320	30 ♀	10.5
		700	144 ♂♀	50.5
		800	28 ♂♀	9.8
		1250	30 ♂♀	10.5
		1500	1 ♀	0.4
		1625	20 ♂♀	7.0
		1850	26 ♂♀	9.1
		2350	6 ♂♀	2.1
	20	500	620 ♂♀	57.9
		750	450 ♂♀	42.1
P-6904	1	415	90 ♂♀	98.9
		1125	1 ♀	1.1

TABLE 51 (continued)

Vertical distribution of <u>Conaea</u> <u>gracilis</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	2	500	310 ♂♀	63.3
		1150	180 ♂♀	36.7
	3	550	210 ♂♀	76.9
		800	1 ♀	0.4
		1700	60 ♂♀	22.0
		2000	2 ♀	0.7
	4	950	21 ♀	67.7
		1925	9 ♀	29.0
		3560	1 ♀	3.2
	5	500	400 ♂♀	75.3
		1033	110 ♂♀	20.7
		1534	1 ♀	0.2
		2000	6 ♂♀	1.1
		2620	5 ♀	0.9
		4105	9 ♂♀	1.7
	6	232	50 ♀	35.2
		1000	40 ♂♀	28.2
		1500	18 ♂♀	12.7
		2042	21 ♂♀	14.8
		2575	3 ♀	2.1
		3144	4 ♂♀	2.8
		3594	3 ♂♀	2.1
		4000	3 ♂♀	2.1
	7	452	30 ♂♀	2.0
		737	660 ♂♀	43.5
		918	800 ♂♀	52.7
		1404	28 ♂♀	1.8
	9	467	180 ♂♀	15.3
		676	960 ♂♀	81.6
		1000	36 ♂♀	3.1
	10	455	300 ♂♀	30.8
		663	350 ♂♀	35.9
		981	248 ♂♀	25.5
		1484	50 ♀	5.1
		1892	12 ♂♀	1.2
		2394	14 ♂♀	1.4
	11	524	340 ♂♀	60.7

TABLE 51 (continued)

Vertical distribution of Conaea gracilis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		759	180 ♂♀	32.1
		1036	40 ♂♀	7.1
	12	515	390 ♂♀	61.3
		781	195 ♂♀	30.7
		1036	51 ♂♀	8.0
	13	258	10 ♀	3.4
		524	112 ♂♀	31.8
		753	102 ♂♀	34.7
		1019	34 ♂♀	11.6
		1638	16 ♂♀	5.4
		2115	14 ♂♀	4.8
		2612	6 ♂♀	2.0
	14	458	60 ♂♀	19.5
		734	175 ♂♀	57.0
		1052	22 ♂♀	7.2
		1454	46 ♂♀	15.0
		1828	3 ♀	1.0
		2336	1 ♀	0.3
	15	524	180 ♂♀	73.5
		791	48 ♂♀	19.6
		1057	8 ♀	3.3
		1500	1 ♀	0.4
		1816	5 ♂♀	2.0
		2248	3 ♂♀	1.2
	16	974	8 ♂♀	72.7
		1500	3 ♂♀	27.3
	17	750	305 ♂♀	67.3
		971	135 ♂♀	29.8
		1408	13 ♂♀	2.9
	18	531	60 ♂♀	20.8
		802	165 ♂♀	57.3
		1033	16 ♀	5.6
		1747	20 ♂♀	6.9
		1942	13 ♂♀	4.5
		2540	14 ♂♀	4.9
	19	550	70 ♂♀	54.3
		904	43 ♂♀	33.3
		1248	5 ♀	3.9

TABLE 51 (continued)

Vertical distribution of Conaea gracilis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1583	2 ♂♀	1.6
		1986	5 ♀	3.9
		2524	4 ♂♀	3.1
	20	537	33 ♂♀	12.9
		827	222 ♂♀	86.7
		1052	1 ♀	0.4
	21	431	12 ♂♀	25.0
		490	36 ♂♀	75.0
	22	372	40 ♂♀	2.6
		450	1320 ♂♀	85.2
		554	60 ♀	3.9
		620	130 ♀	8.4
P-6911	1	459	160 ♂♀	23.0
		715	156 ♂♀	22.4
		911	327 ♂♀	46.9
		1371	22 ♂♀	3.2
		1835	11 ♂♀	1.6
		2337	21 ♂♀	3.0
	2	533	360 ♂♀	85.9
		844	21 ♂♀	5.0
		1272	38 ♂♀	9.1
	3	494	180 ♀	34.5
		739	252 ♂♀	48.3
		1040	70 ♂♀	13.4
		1567	5 ♀	1.0
		2072	15 ♂♀	2.9
	4	423	860 ♂♀	82.3
		836	170 ♂♀	16.3
		1338	10 ♂♀	1.0
		1844	5 ♀	0.5
	5	472	360 ♂♀	54.1
		698	129 ♂♀	19.4
		996	140 ♂♀	21.1
		1878	32 ♂♀	4.8
		2474	4 ♂♀	0.6
	6	481	460 ♂♀	59.8

TABLE 51 (continued)

Vertical distribution of Conaea gracilis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		665	152 ♂♀	19.8
		888	70 ♂♀	9.1
		1324	87 ♂♀	11.3
	7	539	280 ♂♀	49.2
		779	220 ♂♀	38.7
		1000	19 ♂♀	3.3
		1300	50 ♂♀	8.8
	8	510	440 ♂♀	75.5
		995	9 ♂♀	1.5
		1548	54 ♂♀	9.3
		2088	18 ♀	3.1
		2316	62 ♂♀	10.6
	9	515	10 ♂♀	5.1
		1006	96 ♂♀	48.7
		1580	69 ♂♀	35.0
		2088	2 ♀	1.0
		2454	16 ♂♀	8.1
		3442	3 ♂♀	1.5
		3910	1 ♀	0.5
	10	480	580 ♂♀	69.3
		975	102 ♂♀	12.2
		1500	58 ♂♀	6.9
		2032	8 ♂♀	1.0
		2118	44 ♂♀	5.3
		2660	41 ♂♀	4.9
		3176	4 ♂♀	0.5
	11	491	125 ♂♀	38.2
		969	111 ♂♀	33.9
		1570	44 ♂♀	13.5
		2104	18 ♂♀	5.5
		2490	26 ♂♀	8.0
		3602	3 ♂♀	0.9
	12	410	240 ♂♀	25.8
		465	690 ♂♀	74.2
	13	500	260 ♂♀	72.6
		1036	9 ♂♀	2.5
		1601	38 ♂♀	10.6

TABLE 51 (continued)

Vertical distribution of <u>Conaea gracilis</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		2232	22 ♂♀	6.1
		2862	25 ♂♀	7.0
		5200	4 ♂♀	1.1
	14	520	248 ♂♀	37.7
		785	320 ♂♀	48.7
		954	74 ♂♀	11.3
		1443	15 ♂♀	2.3
	15	970	320 ♂♀	92.2
		1424	14 ♂♀	4.0
		1998	4 ♂♀	1.2
		2950	4 ♂♀	1.2
		3932	5 ♂♀	1.4
	16	1525	10 ♂♀	52.6
		2032	9 ♂♀	47.4
	17	514	20 ♀	26.7
		1039	42 ♂♀	56.0
		1590	6 ♀	8.0
		2216	7 ♂♀	9.3

TABLE 52

Vertical distribution of Farranula carinata

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6606	4	0	1200 ♂♀	100.0
	8	0	600 ♂♀	99.2
		2000	5 ♀	0.8
	11	0	50 ♀	100.0
	12	0	8650 ♂♀	100.0
	13	0	400 ♂♀	100.0
	14	10	150 ♀	100.0
P-6701	1	0	3030 ♂♀	98.0
		530	50 ♀	1.6
		845	10 ♂♀	0.3
		1250	3 ♀	0.1
	2	0	140 ♂♀	77.3
		90	30 ♀	16.6
		220	5 ♀	2.8
		500	2 ♀	1.1
		575	4 ♀	2.2
	3	0	50 ♀	83.3
		350	10 ♀	16.7
	4	0	10 ♀	100.0
	5	0	3400 ♂♀	100.0
	8	0	8350 ♂♀	99.6
		70	9 ♂♀	0.1
		250	20 ♀	0.2
		955	1 ♀	0.0
	10	0	21 ♂♀	33.3
		1800	40 ♂♀	63.5
		2200	2 ♀	3.2
	11	0	6 ♀	46.2
		1800	1 ♀	7.7
		2375	6 ♀	46.2
	12	0	540 ♂♀	99.4
		920	2 ♀	0.4
		3200	1 ♀	0.2
	13	0	9950 ♂♀	100.0
	14	0	8650 ♂♀	99.4
		100	50 ♀	0.6
		1650	2 ♀	0.0

TABLE 52 (continued)

Vertical distribution of <u>Farranula carinata</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		2375	2 ♂♀	0.0
	16	0	1020 ♂♀	99.4
		398	3 ♀	0.3
		775	2 ♀	0.2
		1250	1 ♀	0.1
	18	0	2550 ♂♀	99.1
		500	20 ♀	0.8
		1000	1 ♀	0.0
		2200	1 ♀	0.0
		3800	1 ♀	0.0
	20	1050	3 ♀	100.0
	22	1650	1 ♀	50.0
		2000	1 ♀	50.0
	24	0	4800 ♂♀	99.9
		2600	2 ♀	0.0
		3000	2 ♀	0.0
G-6722	4	0	2650 ♂♀	99.9
		1520	3 ♀	0.1
	9	0	31100 ♂♀	99.8
		40	50 ♀	0.2
		562	1 ♀	0.0
	10	0	1700 ♂♀	92.3
		45	130 ♂♀	7.1
		405	3 ♀	0.2
		630	6 ♀	0.3
		1800	2 ♀	0.1
	12	0	4150 ♂♀	98.8
		80	50 ♀	1.2
	15	0	560 ♂♀	96.6
		30	20 ♀	3.4
	17	0	680 ♂♀	99.3
		525	3 ♀	0.4
		2000	2 ♀	0.3
P-6803	4	0	80 ♂♀	11.0
		30	650 ♂♀	89.0
	5	0	450 ♀	100.0
	11	0	1120 ♀	100.0

TABLE 52 (continued)

Vertical distribution of Farranula carinata

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	15	0	10000 ♂♀	100.0
	16	0	900 ♂♀	99.7
		225	1 ♀	0.1
		1000	1 ♀	0.1
		1500	1 ♀	0.1
	17	0	15800 ♂♀	99.9
		100	10 ♀	0.1
		240	10 ♀	0.1
	18	0	4530 ♂♀	99.9
		1500	1 ♀	0.0
		3500	2 ♂♀	0.0
	22	0	170 ♂♀	35.9
		100	300 ♂♀	63.3
		1650	4 ♀	0.8
	25	0	320 ♂♀	95.2
		750	2 ♀	0.6
		1425	14 ♀	4.2
	26	0	15 ♂♀	27.3
		100	40 ♀	72.7
P-6805	2	0	6150 ♂♀	100.0
	3	0	38800 ♂♀	100.0
	4	0	500 ♂♀	99.8
		2323	1 ♀	0.2
	5	0	1800 ♂♀	100.0
	7	50	400 ♀	100.0
	11	2550	1 ♀	100.0
P-6811	1	0	550 ♀	68.7
		38	250 ♀	31.2
	2	0	10 ♀	100.0
	3	0	22400 ♂♀	100.0
	4	0	9400 ♂♀	70.1
		50	4000 ♀	29.8
		1800	1 ♀	0.0
		3250	1 ♀	0.0
	5	0	4300 ♂♀	100.0
		1016	1 ♀	0.0

TABLE 52 (continued)

Vertical distribution of Farranula carinata

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1823	1 ♀	0.0
	6	0	1200 ♂♀	48.0
		25	1300 ♂♀	52.0
	7	0	1050 ♂♀	100.0
	8	0	30 ♀	75.0
		27	10 ♀	25.0
	9	1525	5 ♀	100.0
	10	0	300 ♂♀	46.2
		25	350 ♀	53.8
	11	0	57600 ♂♀	100.0
		1200	1 ♀	0.0
	12	0	10100 ♂♀	96.6
		35	350 ♂♀	3.3
		775	4 ♀	0.0
	14	0	1550 ♂♀	81.5
		40	350 ♀	18.4
		2850	2 ♀	0.1
	15	0	450 ♀	100.0
	16	0	1100 ♂♀	38.6
		52	1750 ♂♀	61.4
		2550	1 ♀	0.0
	17	0	2040 ♂♀	87.9
		85	250 ♂♀	10.8
		237	30 ♀	1.3
	18	0	2000 ♂♀	90.8
		114	200 ♂♀	9.1
		3500	2 ♀	0.1
	19	0	3700 ♂♀	99.9
		75	4 ♀	0.1
	20	0	6120 ♂♀	99.9
		250	4 ♀	0.1
P-6904	1	0	2400 ♂♀	100.0
	2	0	10400 ♂♀	89.3
		14	1250 ♂♀	10.7
	3	0	6750 ♂♀	62.5
		30	4050 ♂♀	37.5

TABLE 52 (continued)

Vertical distribution of <u>Farranula carinata</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	4	0	1440 ♂♀	80.0
		30	360 ♂♀	20.0
	5	0	3540 ♂♀	68.0
		21	1650 ♂♀	31.7
		1033	15 ♀	0.3
		2000	1 ♀	0.0
		2620	3 ♀	0.1
	6	0	4400 ♂♀	97.9
		31	40 ♀	0.9
		232	50 ♀	1.1
		418	1 ♀	0.0
		2575	1 ♀	0.0
		3594	3 ♀	0.1
	7	25	50 ♀	100.0
	9	0	105 ♂♀	100.0
	10	0	78 ♂♀	34.1
		30	150 ♂♀	65.5
		1892	1 ♀	0.4
	11	0	9900 ♂♀	95.6
		45	450 ♀	4.3
		1036	2 ♂	0.0
	12	0	210 ♂♀	11.9
		30	1550 ♂♀	88.1
	13	0	2450 ♂♀	88.7
		48	300 ♀	10.9
		258	10 ♀	0.4
		1638	2 ♂♀	0.1
	14	0	200 ♂♀	76.3
		239	60 ♀	22.9
		1052	2 ♀	0.8
	15	0	1670 ♂♀	69.0
		52	750 ♂♀	31.0
		2248	2 ♀	0.1
	16	0	34 ♂♀	100.0
	17	0	460 ♂♀	100.0
	18	0	90 ♂♀	42.7
		62	120 ♂♀	56.9
		1532	1 ♀	0.5

TABLE 52 (continued)

Vertical distribution of <u>Farranula</u> <u>carinata</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	19	0	4070 ♂♀	76.3
		30	1250 ♂♀	23.4
		550	10 ♀	0.2
		1248	2 ♀	0.0
		1583	3 ♀	0.1
	20	0	30 ♀	0.3
		10	10300 ♂♀	99.7
		258	2 ♂♀	0.0
	21	0	55 ♂♀	13.6
		50	300 ♂♀	74.1
		220	50 ♀	12.3
	22	0	720 ♂♀	50.7
		40	700 ♂♀	49.3
P-6911	1	0	270 ♂♀	100.0
	2	0	1700 ♂♀	97.1
		53	50 ♀	2.9
	3	0	152 ♂♀	2.2
		60	6700 ♂♀	97.5
		1567	13 ♂♀	0.2
		2072	7 ♂♀	0.1
	4	0	240 ♂♀	81.9
		81	50 ♀	17.1
		1338	1 ♀	0.3
		1844	2 ♀	0.7
	5	0	25 ♂♀	29.4
		59	60 ♀	70.6
	6	0	60 ♀	28.6
		50	150 ♀	71.4
	7	0	20 ♂♀	100.0
	8	0	18 ♂♀	1.0
		60	1800 ♂♀	98.9
		1548	2 ♀	0.1
	9	0	10600 ♂♀	94.6
		60	600 ♀	5.4
		1580	3 ♀	0.0
		2088	2 ♂♀	0.0
		3910	1 ♀	0.0

TABLE 52 (continued)

Vertical distribution of Farranula carinata

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	10	0	550 ♂♀	68.7
		56	250 ♀	31.2
	11	0	2050 ♂♀	99.9
		1570	2 ♀	0.1
		4096	1 ♀	0.0
	12	0	123 ♂♀	80.4
		36	30 ♂♀	19.6
	13	65	50 ♀	94.3
		2862	1 ♀	1.9
		5200	2 ♀	3.8
	14	0	660 ♂♀	46.8
		34	750 ♂♀	53.2
		1443	1 ♀	0.1
	15	0	480 ♂♀	56.9
		53	360 ♀	42.7
		970	4 ♀	0.5
	16	0	1050 ♂♀	83.5
		51	200 ♀	15.9
		478	6 ♀	0.5
		1012	1 ♀	0.1
	17	0	530 ♂♀	38.4
		54	850 ♂♀	61.6

TABLE 53

Vertical distribution of <u>Farranula gracilis</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6606	11	2500	1 ♀	100.0
	12	0	2000 ♂♀	100.0
	13	0	150 ♀	100.0
	14	10	50 ♀	100.0
P-6701	5	0	100 ♀	100.0
	10	0	3 ♀	100.0
	12	0	10 ♀	100.0
	13	0	250 ♀	100.0
G-6722	4	0	50 ♀	100.0
	9	0	150 ♀	100.0
	10	0	50 ♀	100.0
	12	0	100 ♀	100.0
P-6803	15	0	140 ♀	100.0
	16	0	20 ♀	100.0
	17	0	150 ♀	100.0
	18	0	90 ♀	100.0
P-6805	2	0	300 ♀	98.4
		1000	5 ♀	1.6
	3	0	2350 ♂♀	99.8
		2250	5 ♀	0.2
	4	0	550 ♂♀	100.0
	5	0	200 ♀	100.0
P-6811	1	38	300 ♀	100.0
	3	0	1200 ♂♀	100.0
	4	0	650 ♀	68.4
		50	300 ♀	31.6
	6	0	200 ♀	100.0
	7	0	30 ♀	100.0
	10	25	100 ♀	96.2
		1000	4 ♀	3.8
	11	0	250 ♀	100.0
	12	35	50 ♀	100.0
	14	0	200 ♀	100.0

TABLE 53 (continued)

Vertical distribution of Farranula gracilis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	16	0	300 ♀	100.0
	18	0	100 ♀	100.0
	19	0	650 ♀	100.0
	20	0	300 ♀	100.0
P-6904	2	0	100 ♀	100.0
	3	0	50 ♀	33.3
		30	100 ♀	66.7
	5	21	100 ♀	100.0
	6	0	50 ♀	100.0
	9	0	5 ♀	100.0
	10	0	2 ♀	6.2
		30	30 ♀	93.7
	11	45	50 ♀	100.0
	12	0	210 ♀	100.0
	13	0	10 ♀	100.0
	15	52	100 ♀	100.0
	16	0	6 ♀	100.0
	20	10	250 ♀	100.0
	21	50	50 ♀	100.0
	22	0	4 ♀	100.0
P-6911	2	0	50 ♀	50.0
		53	50 ♀	50.0
	3	60	150 ♀	100.0
	4	0	20 ♀	100.0
	7	0	4 ♀	100.0
	9	0	50 ♀	100.0
	11	0	50 ♀	100.0
	12	0	6 ♀	100.0
	15	0	30 ♀	100.0
	17	0	10 ♀	100.0

TABLE 54

Vertical distribution of Oithona plumifera

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6606	4	0	500 ♀	9.3
		103	4700 ♂♀	87.0
		285	200 ♀	3.7
	8	0	1900 ♀	50.7
		100	1850 ♂♀	49.3
	11	100	950 ♀	94.5
		500	50 ♀	5.0
		1000	5 ♀	0.5
	12	0	150 ♀	5.9
		100	2200 ♀	86.2
		300	175 ♀	6.9
		500	1 ♀	0.0
		1000	1 ♀	0.0
		1500	25 ♂♀	1.0
	13	0	200 ♀	14.2
		100	1050 ♂♀	74.7
		300	125 ♂♀	8.9
		500	20 ♀	1.4
		1000	10 ♀	0.7
	14	10	250 ♀	4.9
		100	4850 ♂♀	95.1
P-6701	1	530	70 ♂♀	92.1
		1250	1 ♀	1.3
		1725	5 ♀	6.6
	2	0	655 ♀	19.3
		90	2340 ♂♀	68.8
		220	120 ♀	3.5
		350	280 ♀	8.2
		500	2 ♀	0.1
		575	5 ♀	0.1
	3	0	220 ♀	16.0
		115	435 ♂♀	31.7
		250	440 ♂♀	32.0
		350	260 ♀	18.9
		435	12 ♀	0.9
		750	4 ♀	0.3
		970	2 ♀	0.1

TABLE 54 (continued)

Vertical distribution of <u>Oithona plumifera</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	4	0	10♀	23.3
		505	32♀	74.4
		3500	1♀	2.3
	5	0	1950♀	36.7
		90	2950♂♀	55.5
		250	380♂♀	7.2
		504	30♀	0.6
		1000	1♀	0.0
		1830	2♀	0.0
	8	0	1000♀	51.4
		70	6♀	0.3
		250	760♀	39.0
		505	150♀	7.7
		817	20♂♀	1.0
		955	8♀	0.4
		1625	3♀	0.2
	10	0	39♀	1.5
		110	2400♂♀	95.1
		500	16♀	0.6
		1000	25♀	1.0
		1800	30♀	1.2
		2200	8♀	0.3
		2850	6♀	0.2
	11	0	12♀	0.2
		110	5100♂♀	98.0
		500	80♀	1.5
		975	4♀	0.1
		1525	1♀	0.0
		1800	3♀	0.1
		2375	3♀	0.1
	12	0	10♀	0.2
		100	5650♂♀	98.2
		500	80♀	1.4
		920	6♀	0.1
		1450	3♀	0.1
		1825	1♀	0.0
		2450	4♀	0.1
		3200	2♀	0.0

TABLE 54 (continued)

Vertical distribution of *Oithona plumifera*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	13	0	4950 ♀	62.3
		100	2800 ♀	35.2
		450	180 ♀	2.3
		1000	15 ♀	0.2
		1500	1 ♀	0.0
		3100	2 ♀	0.0
		3200	1 ♀	0.0
	14	0	600 ♀	11.1
		100	4750 ♂♀	88.1
		500	20 ♀	0.4
		1650	10 ♀	0.2
		2150	5 ♀	0.1
		2375	1 ♀	0.0
		3850	1 ♀	0.0
		4350	3 ♀	0.1
	16	0	1260 ♀	72.4
		100	460 ♀	26.4
		398	15 ♀	0.9
		775	2 ♀	0.1
		1250	4 ♀	0.2
	18	0	100 ♀	2.7
		100	3400 ♂♀	93.4
		500	120 ♀	3.3
		1000	2 ♀	0.1
		1625	1 ♀	0.0
		2200	5 ♀	0.1
		2650	2 ♀	0.1
		3800	4 ♀	0.1
		4350	5 ♀	0.1
	20	100	1 ♀	0.2
		250	450 ♂♀	97.2
		850	5 ♀	1.1
		1050	4 ♂♀	0.9
		1500	3 ♀	0.6
	22	0	40 ♀	4.6
		100	600 ♀	69.1
		475	210 ♀	24.2
		1000	4 ♀	0.5

TABLE 54 (continued)

Vertical distribution of Oithona plumifera

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1650	5 ♂♀	0.6
		2000	4 ♂♀	0.5
		2350	5 ♀	0.6
	24	0	150 ♀	7.3
		100	1850 ♀	90.6
		500	40 ♀	2.0
		1000	1 ♀	0.0
		2600	1 ♀	0.0
G-6722	4	0	6100 ♀	55.9
		55	4750 ♂♀	43.5
		335	65 ♀	0.6
		1520	2 ♀	0.0
	9	0	750 ♀	19.6
		40	2750 ♀	72.0
		155	220 ♀	5.8
		320	95 ♀	2.5
		875	4 ♀	0.1
		1200	3 ♀	0.1
	10	0	150 ♀	44.8
		45	60 ♀	17.9
		225	100 ♀	29.9
		405	12 ♀	3.6
		630	2 ♀	0.6
		824	1 ♀	0.3
		1800	7 ♂♀	2.1
		3500	2 ♀	0.6
		4500	1 ♀	0.3
	12	0	4850 ♀	77.8
		80	900 ♀	14.4
		181	460 ♀	7.4
		310	20 ♀	0.3
		675	2 ♀	0.0
		1150	3 ♀	0.0
	15	0	80 ♀	40.6
		30	90 ♀	45.7
		132	21 ♀	10.7
		240	3 ♀	1.5

TABLE 54 (continued)

Vertical distribution of *Oithona plumifera*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		450	3♀	1.5
	17	0	40♀	7.7
		55	310♀	60.1
		250	150♀	29.1
		525	6♀	1.2
		1500	2♀	0.4
		2000	8♀	1.5
P-6803	4	0	360♀	10.8
		30	2700♂	80.8
		100	280♀	8.4
	5	0	3600♀	46.5
		40	4150♀	53.5
	8	0	200♀	0.8
		40	15900♂♀	66.2
		95	5900♂♀	24.6
		175	2010♂♀	8.4
	11	0	480♀	9.9
		30	4150♂♀	85.7
		580	180♀	3.7
		1500	2♀	0.0
		2000	4♀	0.1
		2500	28♀	0.6
	15	100	3050♀	87.5
		200	400♂♀	11.5
		400	30♀	0.9
		750	2♀	0.1
		995	2♀	0.1
	16	0	360♂♀	20.5
		100	1360♀	77.6
		225	12♀	0.7
		420	14♀	0.8
		1000	6♀	0.3
		3000	1♀	0.1
	17	0	100♀	7.4
		100	680♀	50.1
		240	330♀	24.3

TABLE 54 (continued)

Vertical distribution of *Oithona plumifera*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		490	240 ♀	17.7
		1000	6 ♀	0.4
		2200	1 ♀	0.1
	18	0	210 ♀	7.0
		100	1880 ♂♀	62.6
		245	860 ♀	28.7
		480	40 ♀	1.3
		1000	7 ♀	0.2
		1500	1 ♀	0.0
		2150	3 ♀	0.1
	20	75	1420 ♂♀	53.0
		125	880 ♀	32.9
		235	330 ♀	12.3
		475	30 ♀	1.1
		740	18 ♀	0.7
	22	0	20 ♀	0.2
		100	9800 ♂♀	80.5
		200	2160 ♀	17.7
		470	180 ♀	1.5
		1650	12 ♀	0.1
	25	250	520 ♀	88.1
		500	20 ♀	3.4
		750	14 ♀	2.4
		1425	36 ♀	6.1
	26	100	3320 ♀	98.6
		150	5 ♀	0.1
		480	40 ♀	1.2
		1000	1 ♀	0.0
P-6805	2	0	350 ♀	8.2
		100	3300 ♀	76.9
		250	620 ♀	14.5
		715	20 ♀	0.5
	3	0	1700 ♀	29.4
		100	3150 ♀	54.4
		250	840 ♀	14.5
		500	90 ♀	1.6
		2250	6 ♀	0.1

TABLE 54 (continued)

Vertical distribution of Oithona plumifera

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		2400	2 ♀	0.0
	4	90	350 ♀	62.5
		500	200 ♂♀	35.7
		1010	10 ♀	1.8
	5	0	500 ♀	14.0
		96	920 ♂♀	25.7
		250	1520 ♀	42.5
		340	630 ♂♀	17.6
		500	6 ♀	0.2
		770	1 ♀	0.0
	7	0	100 ♀	1.2
		50	8300 ♂♀	98.8
		2300	1 ♀	0.0
	9	0	100 ♀	2.4
		65	4050 ♀	96.0
		250	30 ♀	0.7
		500	40 ♀	0.9
	10	0	50 ♀	6.2
		55	400 ♀	50.0
		245	350 ♀	43.7
	11	250	950 ♂♀	94.4
		537	20 ♀	2.0
		1050	20 ♀	2.0
		1700	9 ♀	0.9
		2263	3 ♀	0.3
		2550	3 ♀	0.3
		4517	1 ♀	0.1
P-6811	1	0	550 ♀	17.1
		38	1850 ♀	57.4
		250	690 ♀	21.4
		500	120 ♂♀	3.7
		750	10 ♀	0.3
		950	5 ♀	0.2
	2	77	2500 ♀	90.8
		237	200 ♀	7.3
		508	20 ♀	0.7
		822	20 ♀	0.7
		1000	12 ♀	0.4
		1200	1 ♀	0.0
	3	0	100 ♀	6.2
		63	5 ♀	0.3

TABLE 54 (continued)

Vertical distribution of Oithona plumifera

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		225	1470♀	91.0
		770	36♀	2.2
		1450	2♀	0.1
		1800	2♀	0.1
	4	0	1550♀	9.7
		50	14000♂♀	87.2
		270	440♀	2.7
		550	40♀	0.3
		1050	5♀	0.0
		1800	3♀	0.0
		2150	1♀	0.0
		2312	2♀	0.0
		3000	8♀	0.1
	5	0	300♀	5.9
		25	2300♀	45.1
		250	2500♀	49.0
		750	2♀	0.0
		1823	1♀	0.0
	6	0	500♀	10.1
		25	3450♀	69.8
		250	960♂♀	19.4
		485	30♀	0.6
		1750	1♀	0.0
		2025	1♀	0.0
	7	90	6120♂♀	68.6
		125	1320♀	14.8
		225	850♀	9.5
		275	360♀	4.0
		375	140♀	1.6
		500	130♀	1.5
	8	0	150♀	8.8
		27	490♀	28.6
		238	980♀	57.2
		480	10♀	0.6
		713	80♀	4.7
		2450	3♀	0.2
	9	50	17400♂♀	96.6

TABLE 54 (continued)

Vertical distribution of Oithona plumifera

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		230	550 ♀	3.1
		635	60 ♀	0.3
		875	1 ♀	0.0
		1400	1 ♀	0.0
	10	25	600 ♀	70.6
		250	200 ♀	23.5
		500	30 ♀	3.5
		1000	20 ♀	2.4
	11	45	2450 ♀	86.0
		285	275 ♀	9.6
		590	125 ♀	4.4
	12	0	200 ♀	2.8
		35	6650 ♀	94.2
		160	110 ♀	1.6
		290	90 ♀	1.3
		550	3 ♀	0.0
		775	8 ♀	0.1
		1100	2 ♀	0.0
	14	0	3400 ♀	47.2
		40	3550 ♀	49.3
		285	200 ♀	2.8
		590	40 ♀	0.6
		800	10 ♀	0.1
		1175	1 ♀	0.0
		2850	4 ♀	0.1
	15	0	3650 ♂♀	82.2
		55	240 ♀	5.4
		237	540 ♂♀	12.2
		1000	8 ♀	0.2
	16	0	550 ♀	15.9
		52	2100 ♀	60.7
		250	800 ♂♀	23.1
		750	5 ♀	0.1
		1000	2 ♀	0.1
	17	85	11700 ♂♀	94.6
		237	600 ♀	4.9
		485	60 ♀	0.5
		1500	2 ♀	0.0
	18	0	3950 ♀	55.4
		114	2750 ♂♀	38.5
		260	240 ♀	3.4

TABLE 54 (continued)

Vertical distribution of <u>Oithona plumifera</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		525	180♀	2.5
		763	8♀	0.1
		1050	4♀	0.1
		1900	1♀	0.0
		2500	1♀	0.0
		3500	1♀	0.0
	19	0	1950♀	90.6
		75	10♀	0.5
		320	180♀	8.4
		700	6♀	0.3
		1250	2♀	0.1
		1625	4♀	0.2
	20	0	30♀	3.2
		75	850♂♀	90.8
		250	36♂♀	3.8
		500	20♀	2.1
P-6904	1	0	100♀	7.0
		38	1250♀	87.2
		215	4♀	0.3
		415	80♀	5.6
	2	0	450♀	16.3
		14	1800♀	65.2
		265	440♀	15.9
		500	60♀	2.2
		1150	10♀	0.4
	3	0	550♀	25.8
		30	1250♂♀	58.6
		265	270♀	12.6
		550	60♀	2.8
		1050	1♀	0.0
		1700	2♀	0.1
		2000	1♀	0.0
		3000	1♀	0.0
	4	30	420♀	22.3
		230	1300♂♀	69.1
		470	150♂♀	8.0
		1400	2♀	0.1

TABLE 54 (continued)

Vertical distribution of Oithona plumifera

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1925	5♀	0.3
		3560	5♀	0.3
	5	0	30♀	0.9
		21	3000♀	85.2
		250	480♀	13.6
		1033	10♀	0.3
		1534	1♀	0.0
		2620	1♀	0.0
		4105	1♀	0.0
	6	31	1280♀	49.2
		232	1300♀	50.0
		418	9♀	0.3
		1000	4♀	0.2
		1500	2♀	0.1
		2575	1♀	0.0
		3144	3♀	0.1
		3594	1♀	0.0
	7	25	400♂♀	33.3
		241	540♀	45.0
		452	170♂♀	14.2
		737	70♀	5.8
		918	20♀	1.7
	9	70	460♀	17.7
		236	1590♀	61.2
		467	510♀	19.6
		676	40♀	1.5
	10	0	2♀	0.3
		30	390♀	56.4
		233	240♂♀	34.7
		455	40♀	5.8
		663	10♀	1.4
		1484	5♀	0.7
		1892	1♀	0.1
		2394	4♀	0.6
	11	0	200♀	1.9
		45	9550♀	91.8
		262	580♀	5.6

TABLE 54 (continued)

Vertical distribution of <u>Oithona</u> <u>plumifera</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		524	50♀	0.5
		759	20♀	0.2
	12	0	60♀ imm.	1.3
		30	4600♂♀	96.7
		259	70♀	1.5
		515	20♀	0.4
		781	5♀	0.1
	13	0	100♀	3.1
		48	2950♀	90.9
		258	120♀	3.7
		524	64♂♀	2.0
		753	6♀	0.2
		2612	4♀	0.1
	14	37	820♂♀	70.2
		239	300♂♀	25.7
		458	40♀	3.4
		734	5♀	0.4
		1828	2♀	0.2
		2336	1♀	0.1
	15	52	2950♂♀	93.9
		261	126♀	4.0
		524	60♀	1.9
		791	4♀	0.1
		2248	1♀	0.0
	16	0	6♀	0.4
		59	1120♀	79.5
		253	280♀	19.9
		519	1♀	0.1
		1500	1♀	0.1
	17	45	140♀	19.5
		251	560♀	78.1
		750	10♀	1.4
		971	6♀	0.8
		1408	1♀	0.1
	18	0	10♀	0.4
		62	1360♂♀	52.0
		261	990♂♀	37.9
		531	200♀	7.7

TABLE 54 (continued)

Vertical distribution of Oithona plumifera

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		802	15♀	0.6
		1033	20♀	0.8
		1532	5♀	0.2
		1942	1♀	0.0
		2540	12♀	0.5
	19	0	30♀	1.1
		30	2250 ♂♀	83.9
		274	400♀	14.9
		2524	1♀	0.0
	20	10	1100♀	92.3
		258	56♀	4.7
		537	30♀	2.5
		827	6♀	0.5
	21	0	10♀	0.3
		50	2600 ♂♀	68.1
		220	900 ♂♀	23.6
		297	300♀	7.8
		431	6♀	0.2
		490	3♀	0.1
	22	40	6350 ♂♀	57.4
		252	900 ♂♀	8.1
		372	360 ♂♀	3.3
		450	3270♀	29.5
		554	180♀	1.6
		620	10♀	0.1
P-6911	1	0	180♀	1.8
		65	7150 ♂♀	73.2
		250	2200 ♂♀	22.5
		459	200♀	2.0
		715	6♀	0.1
		911	15♀	0.2
		1371	6♀	0.1
		1835	10 ♂♀	0.1
		2337	2♀	0.0
	2	0	450♀	9.4
		53	3100 ♂♀	64.7
		242	1080 ♂♀	22.5

TABLE 54 (continued)

Vertical distribution of <u>Oithona plumifera</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		533	160♀	3.3
		844	2♀	0.0
	3	0	10♀	0.1
		60	15600♂♀	92.2
		274	1100♀	6.5
		494	110♀	0.7
		739	42♀	0.2
		1040	15♀	0.1
		1567	38♀	0.2
		2072	6♀	0.0
	4	0	360♀	7.5
		81	3900♀	81.5
		218	380♂♀	7.9
		423	120♀	2.5
		836	20♀	0.4
		1338	4♀	0.1
		1844	2♀	0.0
	5	0	130♀	2.5
		59	2340♀	44.9
		237	2600♂♀	49.9
		472	100♀	1.9
		698	2♀	0.0
		996	10♀	0.2
		1878	24♀	0.5
		2474	2♀	0.0
	6	0	80♀	0.7
		50	11500♂♀	98.2
		481	120♀	1.0
		665	4♀	0.0
		888	4♀	0.0
		1324	3♀	0.0
	7	0	12♀	0.4
		60	2460♂♀	77.8
		253	420♂♀	13.3
		539	240♀	7.6
		779	20♀	0.6
		1000	3♀	0.1

TABLE 54 (continued)

Vertical distribution of Oithona plumifera

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1300	6 ♀	0.2
	8	0	1 ♀	0.0
		60	6450 ♂♀	90.4
		243	510 ♂♀	7.1
		510	140 ♀	2.0
		995	9 ♀	0.1
		2088	10 ♀	0.1
		2316	12 ♀	0.2
		3304	1 ♀	0.0
		3942	2 ♀	0.0
	9	0	650 ♀	4.7
		60	12100 ♂♀	87.8
		250	1000 ♀	7.3
		515	10 ♀	0.1
		1006	3 ♀	0.0
		1580	3 ♀	0.0
		2088	10 ♀	0.1
		2454	3 ♀	0.0
		3910	5 ♀	0.0
	10	0	750 ♂♀	7.7
		56	8000 ♂♀	82.6
		227	840 ♂♀	8.7
		480	60 ♀	0.6
		975	20 ♀	0.2
		2032	2 ♀	0.0
		2118	8 ♀	0.1
		2660	6 ♂♀	0.1
		3176	2 ♀	0.0
	11	0	500 ♀	7.0
		58	6400 ♂♀	89.1
		234	270 ♀	3.8
		1570	6 ♀	0.1
		2104	1 ♀	0.0
		2490	2 ♀	0.0
		3602	2 ♀	0.0
		4096	1 ♀	0.0
	12	0	69 ♀	2.9

TABLE 54 (continued)

Vertical distribution of Oithona plumifera

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		36	310♀	13.0
		78	1080♀	45.3
		153	80♀	3.4
		200	36♀	1.5
		258	9♀	0.4
		296	440♀	18.5
		344	240♀	10.1
		410	60♀	2.5
		465	60♀	2.5
	13	0	100♀	1.1
		65	9000♂♀	97.5
		269	120♀	1.3
		500	8♀	0.1
		1601	2♀	0.0
		2232	1♀	0.0
		2862	1♀	0.0
		5200	2♀	0.0
	14	0	540♀	4.2
		34	12300♂♀	95.7
		265	1♀	0.0
		785	5♀	0.0
	15	0	510♂♀	6.9
		53	6120♂♀	83.0
		224	660♀	9.0
		445	65♀	0.9
		970	12♂♀	0.2
		1424	1♀	0.0
		1998	2♀	0.0
	16	0	150♀	7.1
		51	1560♀	73.7
		243	380♀	17.9
		478	27♀	1.3
		1012	1♀	0.0
	17	0	50♀	2.8
		54	900♂♀	51.0
		261	780♀	44.2
		514	30♀	1.7
		1039	3♀	0.2

TABLE 55

Vertical distribution of <u>Oncaea</u> <u>mediterranea</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER		PER CENT
P-6606	4	0	600 ♂♀		21.7
		103	2100 ♂♀	imm.	76.1
		285	25 ♀		0.9
		593	25 ♀		0.9
		700	10 ♀		0.4
	8	0	650 ♂♀		22.7
		100	2150 ♂♀		75.2
		500	50 ♀		1.7
		2000	10 ♂♀		0.3
	11	100	700 ♂♀		92.1
		500	50 ♀		6.6
		1000	10 ♀		1.3
	12	0	1300 ♂♀		36.8
		100	2150 ♂♀		60.9
		300	75 ♀		2.1
		500	1 ♀		0.0
		1500	5 ♀		0.1
	13	0	50 ♀		13.0
		100	225 ♂♀		58.4
		300	50 ♀		13.0
		500	60 ♀		15.6
	14	100	700 ♂♀		100.0
P-6701	1	0	10 ♀		18.2
		530	45 ♀		81.8
	2	0	5 ♀		10.2
		90	30 ♀		61.2
		500	14 ♀		28.6
	3	115	10 ♀		52.6
		435	8 ♀		42.1
		750	1 ♀		5.3
	4	0	5 ♀		100.0
	5	0	150 ♀		53.4
		90	50 ♀		17.8
		250	20 ♀		7.1
		504	60 ♀		21.4
		1000	1 ♀		0.4
	8	505	30 ♀		100.0

TABLE 55 (continued)

Vertical distribution of <u>Oncaea</u> <u>mediterranea</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	10	110	300♀	78.1
		500	6♀	1.6
		1000	45♀	11.7
		1800	25♀	6.5
		2200	2♀	0.5
		2850	6♀	1.6
	11	110	50♀	83.3
		500	10♀	16.7
	12	500	50♀	100.0
	13	0	150♀	42.9
		100	50♀	14.3
		450	150♂♀	42.9
	14	100	100♀	100.0
	16	398	12♀	85.7
		775	2♀	14.3
	18	100	150♀	98.0
		1000	1♀	0.7
		1625	1♀	0.7
		2200	1♀	0.7
	20	250	120♀	92.3
		850	7♀	5.4
		1050	1♀	0.8
		1500	2♀	1.5
	22	100	30♀	54.5
		1650	12♀	21.8
		2000	11♂♀	20.0
		2350	2♀	3.6
	24	100	100♀	99.0
		1000	1♀	1.0
G-6722	4	55	200♀	95.2
		335	10♀	4.8
	9	40	50♀	90.9
		320	5♀	9.1
	10	0	100♀	90.9
		225	5♀	4.5
		405	3♀	2.7

TABLE 55 (continued)

Vertical distribution of <u>Oncaea mediterranea</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		630	2 ♀	1.8
	12	0	1100 ♂♀	71.0
		80	400 ♂♀	25.8
		181	40 ♀	2.6
		310	10 ♀	0.6
	15	132	27 ♀	79.4
		240	1 ♀	2.9
		450	2 ♀	5.9
		635	4 ♀	11.8
	17	0	40 ♀	27.6
		250	100 ♂♀	69.0
		525	3 ♀	2.1
		1000	1 ♀	0.7
		2000	1 ♀	0.7
P-6803	4	0	80 ♂♀	10.0
		30	550 ♂♀	68.7
		100	170 ♀	21.2
	5	0	400 ♂♀	27.6
		40	1050 ♀	72.4
	8	0	60 ♀	2.0
		40	2400 ♀	80.0
		95	300 ♀	10.0
		175	240 ♀	8.0
	11	1030	3 ♀	20.0
		1500	4 ♀	26.7
		2500	8 ♀	53.3
	15	200	60 ♀	60.0
		400	40 ♀	40.0
	16	0	80 ♀	42.3
		100	100 ♂♀	52.9
		225	1 ♀	0.5
		420	8 ♀	4.2
	17	0	750 ♀	97.4
		100	10 ♀	1.3
		240	10 ♀	1.3
	18	0	30 ♀	13.0

TABLE 55 (continued)

Vertical distribution of <u>Oncaea mediterranea</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		245	200 ♀	86.6
		2150	1 ♀	0.4
	20	75	40 ♀	26.7
		125	40 ♀	26.7
		235	70 ♀	46.7
	22	200	30 ♀	96.8
		1650	1 ♀	3.2
	25	750	8 ♀	80.0
		1425	2 ♀	20.0
P-6805	2	0	300 ♂♀	19.2
		100	1200 ♂♀	76.7
		250	60 ♀	3.8
		440	5 ♀	0.3
	3	0	900 ♂♀	43.1
		100	800 ♂♀	38.3
		250	120 ♂♀	5.7
		500	270 ♂♀	12.9
	4	0	250 ♂♀	16.1
		90	250 ♂♀	16.1
		500	1050 ♂♀	67.7
	5	0	100 ♀	30.3
		96	60 ♀	18.2
		250	80 ♀	24.2
		340	90 ♂♀	27.3
	7	0	200 ♀	100.0
	9	250	30 ♀	27.3
		500	80 ♀	72.7
	11	250	50 ♀	100.0
P-6811	1	0	100 ♀	16.7
		38	200 ♀	33.3
		250	180 ♂♀	30.0
		500	120 ♂♀	20.0
	2	0	10 ♀	16.7
		237	50 ♀	83.3
	3	225	90 ♀	100.0

TABLE 55 (continued)

Vertical distribution of <u>Oncaea</u> <u>mediterranea</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	4	0	1250♀	16.8
		50	6150♂♀	82.4
		270	20♀	0.3
		550	40♀	0.5
	5	0	100♀	20.0
		25	400♀	80.0
	6	0	400♂♀	32.5
		25	700♂♀	56.9
		250	40♀	3.3
		485	90♀	7.3
	7	125	80♂♀	42.1
		225	50♀	26.3
		375	60♂♀	31.6
	8	238	180♂♀	95.2
		1000	5♀	2.6
		1500	4♀	2.1
	9	50	200♀	78.4
		230	50♀	19.6
		450	5♀	2.0
	10	25	100♀	40.0
		250	150♂♀	60.0
	11	285	50♀	20.0
		590	200♂♀	80.0
	12	35	400♂♀	100.0
	15	0	50♀	100.0
	16	500	2♀	100.0
	17	237	30♀	100.0
	18	0	400♀	68.8
		525	180♂♀	31.0
		1900	1♀	0.2
	19	320	150♂♀	99.3
		1625	1♀	0.7
	20	0	60♂♀	35.3
		500	100♀	58.8
		750	10♀	5.9
P-6904	1	0	250♂♀	29.7

TABLE 55 (continued)

Vertical distribution of <u>Oncaea</u> <u>mediterranea</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		38	350♀	41.6
		415	240♂♀	28.5
		795	1♀	0.1
	2	0	350♀	39.8
		14	500♀	56.8
		500	20♀	2.3
		1150	10♀	1.1
	3	30	50♀	12.2
		265	330♂♀	80.5
		550	30♀	7.3
	4	30	30♀	10.7
		230	200♀	71.4
		470	50♀	17.9
	5	0	30♀	7.3
		250	200♀	48.8
		500	180♂♀	43.9
	6	232	100♀	94.3
		2042	1♀	0.9
		3144	5♀	4.7
	7	241	100♀	76.9
		452	10♀	7.7
		737	20♀	15.4
	9	236	210♂♀	87.5
		467	30♀	12.5
	10	233	10♀	32.3
		455	20♀	64.5
		1892	1♀	3.2
	11	262	20♀	28.6
		524	50♀	71.4
	12	30	150♂♀	100.0
	13	524	40♀	85.1
		753	6♀	12.8
		2612	1♀	2.1
	14	239	60♀	85.7
		458	10♀	14.3
	15	52	50♀	65.8
		261	6♀	7.9

TABLE 55 (continued)

Vertical distribution of <u>Oncaea</u> <u>mediterranea</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		524	20♀	26.3
	16	59	40♀	66.7
		253	20♀	33.3
	17	45	60♀	41.4
		251	80♀	55.2
		750	5♀	3.4
	18	62	180♀	60.0
		261	90♀	30.0
		531	20♀	6.7
		802	5♀	1.7
		1033	2♀	0.7
		1532	1♀	0.3
		2540	2♀	0.7
	19	30	100♀	41.7
		274	20♀	8.3
		550	120♂♀	50.0
	20	258	3♀	16.7
		537	15♀	83.3
	21	50	150♀	27.6
		220	200♂♀	36.8
		297	180♂♀	33.1
		431	10♀	1.8
		490	3♀	0.6
	22	40	250♂♀	43.1
		252	60♀	10.4
		372	20♂♀	3.5
		450	180♂♀	31.0
		554	60♀	10.3
		620	10♀	1.7
P-6911	1	250	300♀	88.2
		459	40♀	11.8
	2	53	400♂♀	52.6
		242	300♀	39.5
		533	60♀	7.9
	3	494	20♀	76.9
		1567	2♀	7.7

TABLE 55 (continued)

Vertical distribution of Oncaea mediterranea

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		2556	4 ♂♀	15.4
	4	0	20 ♀	7.7
		81	200 ♂♀	76.9
		423	40 ♀	15.4
	5	59	120 ♀	27.3
		237	300 ♀	68.2
		474	20 ♀	4.5
	6	0	40 ♀	10.5
		50	300 ♀	78.5
		481	40 ♀	10.5
		888	2 ♀	0.5
	7	60	40 ♀	26.7
		253	90 ♀	60.0
		539	20 ♀	13.3
	8	60	2200 ♂♀	75.6
		243	630 ♀	21.6
		510	80 ♀	2.7
	9	0	50 ♀	5.3
		60	850 ♂♀	89.5
		250	50 ♀	5.3
	10	0	250 ♂♀	11.5
		56	1850 ♂♀	85.3
		480	60 ♀	2.8
		1500	2 ♀	0.1
		2118	8 ♀	0.4
	11	0	350 ♂♀	18.3
		58	1450 ♀	75.7
		234	90 ♀	4.7
		491	20 ♀	1.0
		969	3 ♀	0.2
		2104	3 ♀	0.2
	12	36	20 ♀	8.5
		153	20 ♀	8.5
		200	4 ♀	1.7
		344	40 ♀	17.1
		410	120 ♀	51.3
		465	30 ♀	12.8

TABLE 55 (continued)

Vertical distribution of <u>Oncaea mediterranea</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	13	65	450♀	95.9
		269	10♀	2.1
		500	8♀	1.7
		2232	1♀	0.2
	14	520	4♀	100.0
	15	53	40♀	44.0
		224	30♀	33.0
		445	20♀	22.0
		2950	1♀	1.1
	16	243	60♀	100.0
	17	514	10♀	100.0

TABLE 56

Vertical distribution of <u>Oncaea venusta</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER		PER CENT
P-6606	4	0	500♀		7.7
		103	6000♂♀	imm.	92.2
		700	10♀		0.2
	8	0	900♂♀		60.0
		100	600♂♀		40.0
	11	0	600♀		91.3
		500	50♀		7.6
		1000	5♀		0.8
		2500	2♀		0.3
	12	0	1100♂♀		53.6
		100	950♂♀		46.3
		500	2♀		0.1
		1000	1♀		0.0
	13	0	50♀		26.3
		100	75♂♀		39.5
		500	60♂♀		31.6
		1000	5♀		2.6
	14	10	50♀		25.0
		100	150♀		75.0
P-6701	1	0	1210♀		98.6
		530	15♀		1.2
		1250	2♀		0.2
	2	0	110♀		50.0
		90	90♀		40.9
		350	20♀		9.1
	3	0	90♀		94.7
		115	5♀		5.3
	4	0	5♀		71.4
		1000	2♀		28.6
	5	0	950♀		86.4
		90	150♀		13.6
	8	0	5200♂♀		99.6
		70	8♀		0.2
		505	10♀		0.2
		955	2♀		0.0
	10	0	24♀		0.4

TABLE 56 (continued)

Vertical distribution of Oncaea venusta

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		110	5650 ♂♀	98.2
		500	1 ♀	0.0
		1000	5 ♀	0.1
		1800	65 ♀	1.1
		2200	10 ♂♀	0.2
	11	0	34 ♂♀	11.9
		110	250 ♀	87.4
		1525	2 ♀	0.7
	12	0	360 ♀	76.6
		100	100 ♀	21.3
		1450	6 ♀	1.3
		2450	1 ♀	0.2
		3200	3 ♀	0.6
	13	0	1800 ♂♀	94.1
		100	50 ♀	2.6
		450	60 ♀	3.1
		1500	1 ♀	0.1
		3200	2 ♀	0.1
	14	0	2950 ♀	93.4
		100	200 ♀	6.3
		1650	3 ♀	0.1
		2150	2 ♀	0.1
		2375	2 ♀	0.1
		4350	1 ♀	0.0
	16	0	300 ♀	94.9
		398	9 ♀	2.8
		775	3 ♀	0.9
		1250	4 ♀	1.3
	18	0	50 ♀	31.2
		100	100 ♀	62.5
		1000	3 ♀	1.9
		1625	1 ♀	0.6
		2200	4 ♂♀	2.5
		2650	1 ♀	0.6
		4350	1 ♀	0.6
	20	250	30 ♀	83.3
		850	5 ♀	13.9

TABLE 56 (continued)

Vertical distribution of <u>Oncaea venusta</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1050	1♀	2.8
	22	1650	1♀	11.1
		2000	7♀	77.8
		2350	1♀	11.1
	24	0	200♀	49.9
		100	200♀	49.9
		1000	1♀	0.2
G-6722	4	0	1100♂♀	68.7
		55	500♀	31.2
	9	0	1150♀	84.8
		40	200♀	14.7
		562	1♀	0.1
		875	5♀	0.4
	10	0	900♀	98.6
		405	3♀	0.3
		1800	4♀	0.4
		3500	6♀	0.7
	12	0	900♀	52.9
		80	800♀	47.1
	15	0	240♀	82.8
		30	50♀	17.2
	17	0	880♀	86.5
		55	130♀	12.8
		525	3♀	0.3
		2000	4♀	0.4
P-6803	4	0	120♀	26.7
		30	300♀	66.7
		100	30♀	6.7
	5	0	1100♀	88.0
		40	150♀	12.0
	8	0	20♀	0.8
		40	2300♀	94.7
		95	50♀	2.1
		175	60♀	2.5

TABLE 56 (continued)

Vertical distribution of Oncaea venusta

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	11	0	920 ♂♀	44.6
		30	1100 ♂♀	53.3
		580	30 ♀	1.5
		2500	12 ♀	0.6
	15	0	320 ♀	74.4
		100	50 ♀	11.6
		200	60 ♀	14.0
	16	0	200 ♀	100.0
	17	0	500 ♀	100.0
	18	0	270 ♂♀	67.3
		100	80 ♀	20.0
		245	40 ♀	10.0
		480	10 ♀	2.5
		2150	1 ♀	0.2
	20	125	160 ♀	94.1
		235	10 ♀	5.9
	22	100	100 ♀	83.3
		470	20 ♀	16.7
	25	500	220 ♂♀	100.0
	26	150	1 ♀	4.8
		480	20 ♀	95.2
P-6805	2	100	1050 ♂♀	100.0
	3	0	800 ♂♀	37.7
		100	1200 ♂♀	56.5
		250	120 ♂♀	5.6
		2400	4 ♀	0.2
	4	0	550 ♀	100.0
	5	250	40 ♀	100.0
	7	0	400 ♂♀	11.4
		50	3100 ♂♀	88.3
		1000	10 ♀	0.3
	9	0	100 ♀	49.8
		65	100 ♂♀	49.8
		1438	1 ♀	0.5
	10	0	50 ♀	100.0

TABLE 56 (continued)

Vertical distribution of Oncaea venusta

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6811	1	0	350 ♀	19.9
		38	1250 ♂♀	71.0
		250	120 ♂♀	6.8
		500	40 ♂	2.3
	2	0	10 ♀	2.4
		77	350 ♂♀	84.5
		237	50 ♀	12.1
		1000	4 ♀	1.0
	3	0	5350 ♀	99.9
		63	2 ♀	0.0
		770	4 ♀	0.1
	4	0	2400 ♀	49.0
		50	2500 ♂♀	51.0
	5	0	2700 ♂♀	84.3
		25	500 ♀	15.6
		1016	1 ♀	0.0
	6	0	900 ♂♀	54.5
		25	750 ♂♀	45.5
	7	125	40 ♀	80.0
		500	10 ♀	20.0
	8	27	30 ♂♀	100.0
	9	0	200 ♂♀	56.3
		50	100 ♀	28.2
		230	50 ♀	14.1
		1525	5 ♀	1.4
	10	0	200 ♀	9.4
		25	1650 ♀	77.5
		250	250 ♂♀	11.7
		500	30 ♀	1.4
	11	0	1400 ♂♀	90.3
		45	150 ♂♀	9.7
	12	0	350 ♂♀	69.4
		35	100 ♀	19.8
		160	50 ♀	9.9
		775	4 ♀	0.8
	14	0	1200 ♀	99.0
		590	10 ♀	0.8

TABLE 56 (continued)

Vertical distribution of Oncaea venusta

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		2850	2 ♀	0.2
	16	0	650 ♂♀	61.9
		52	400 ♀	38.1
	17	237	60 ♀	100.0
	18	0	2300 ♂♀	90.1
		114	150 ♀	5.9
		525	100 ♀	3.9
		1050	2 ♀	0.1
		1900	1 ♀	0.0
	19	0	750 ♀	85.6
		75	4 ♀	0.5
		320	120 ♂♀	13.7
		1625	1 ♀	0.1
		1850	1 ♀	0.1
	20	0	570 ♂♀	52.3
		75	500 ♂♀	45.9
		500	20 ♀	1.8
P-6904	1	0	700 ♂♀	48.5
		38	700 ♂♀	48.5
		215	2 ♀	0.1
		415	40 ♀	2.8
	2	0	1050 ♀	36.7
		14	1750 ♂♀	61.2
		265	60 ♂♀	2.1
	3	0	750 ♀	8.3
		30	7400 ♂♀	81.7
		265	900 ♂♀	9.9
		1050	2 ♀	0.0
		1700	4 ♀	0.0
		2000	1 ♀	0.0
	4	0	60 ♀	8.4
		30	30 ♀	4.2
		230	275 ♀	38.5
		470	350 ♂♀	49.0
	5	21	200 ♀	66.7
		250	80 ♂♀	26.7
		500	20 ♂♀	6.7

TABLE 56 (continued)

Vertical distribution of <u>Oncaea venusta</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	6	0	300 ♂♀	36.5
		31	120 ♀	14.6
		232	400 ♀	48.7
		3144	2 ♀	0.2
	7	25	200 ♂♀	80.0
		241	40 ♀	16.0
		737	10 ♀	4.0
	9	0	55 ♀	8.8
		70	120 ♀	19.2
		236	330 ♂♀	52.8
		467	120 ♂♀	19.2
	10	0	5 ♂♀	19.2
		233	10 ♀	38.5
		455	10 ♂	38.5
		1892	1 ♀	3.8
	11	0	1300 ♂♀	80.7
		45	200 ♀	12.4
		262	40 ♂♀	2.5
		524	70 ♂♀	4.3
	12	0	60 ♀	4.3
		30	1350 ♀	95.7
	13	0	200 ♀	83.3
		524	40 ♂	16.7
	14	0	25 ♀	7.2
		37	20 ♀	5.8
		239	300 ♂♀	87.0
	15	52	50 ♀	67.6
		261	24 ♀	32.4
	16	59	240 ♀	99.2
		974	1 ♀	0.4
		1500	1 ♀	0.4
	17	0	20 ♀	5.2
		45	200 ♂♀	51.9
		251	160 ♀	41.6
		750	5 ♀	1.3
	18	0	15 ♀	5.3
		62	180 ♀	64.1

TABLE 56 (continued)

Vertical distribution of Oncaea venusta

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		261	60 ♀	21.4
		531	20 ♀	7.1
		1033	6 ♂♀	2.1
	19	30	300 ♀	65.2
		274	160 ♀	34.8
	20	10	450 ♀	100.0
	21	0	60 ♂♀	2.9
		50	1100 ♀	53.9
		220	500 ♂♀	24.5
		297	380 ♂♀	18.6
	22	0	40 ♀	8.2
		40	350 ♂♀	71.4
		252	30 ♀	6.1
		450	60 ♀	12.2
		620	10 ♀	2.0
P-6911	1	65	200 ♀	79.7
		250	50 ♀	19.9
		1835	1 ♀	0.4
	2	0	350 ♂♀	46.7
		53	400 ♂♀	53.3
	3	60	100 ♀	96.2
		2072	3 ♀	2.9
		2556	1 ♀	1.0
	4	0	60 ♀	16.6
		81	300 ♀	82.9
		1338	1 ♀	0.3
		1844	1 ♀	0.3
	5	59	60 ♀	53.6
		237	50 ♀	44.6
		1878	2 ♀	1.8
	6	0	60 ♀	14.6
		50	350 ♀	85.0
		665	2 ♀	0.5
	7	0	28 ♀	10.8
		60	80 ♀	30.9
		253	150 ♀	57.9
		1000	1 ♀	0.4

TABLE 56 (continued)

Vertical distribution of <u>Oncaea venusta</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	8	0	3♀	0.1
		60	2000♂♀	92.2
		243	150♀	6.9
		995	1♀	0.0
		1548	2♀	0.1
		2088	10♀	0.5
		2316	4♀	0.2
	9	0	4600♂♀	74.8
		60	1500♂♀	24.4
		250	50♂	0.8
		2088	2♀	0.0
		3910	1♀	0.0
	10	0	350♀	31.8
		56	750♀	68.1
		3176	1♀	0.1
	11	0	550♂♀	54.8
		58	450♀	44.8
		1570	2♀	0.2
		4096	2♀	0.2
	12	0	69♀	39.2
		36	60♀	34.1
		78	40♀	22.7
		200	4♀	2.3
		258	3♀	1.7
	13	0	600♀	29.0
		65	1450♀	70.2
		269	10♀	0.5
		2232	2♀	0.1
		5200	4♀	0.2
	14	0	210♀	10.4
		34	1800♀	89.5
		265	2♀	0.1
	15	0	300♀	77.5
		53	80♀	20.7
		970	4♀	1.0
		1998	3♀	0.8
	16	0	120♀	37.5

TABLE 56 (continued)

Vertical distribution of *Oncaea venusta*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		51	200♀	62.5
	17	54	250♀	100.0

TABLE 57

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6606	4	0	5100	23.2
		103	15600	70.9
		285	1270	5.8
		593	25	0.1
	8	0	2900	24.3
		100	4150	34.8
		500	4170	34.9
		1000	650	5.4
		2000	65	0.5
	11	0	2050	22.7
		100	2650	29.4
		500	4250	47.1
		1000	30	0.3
		2000	45	0.5
	12	0	12700	44.2
		100	14700	51.1
		300	1250	4.3
		500	1	0.0
		1500	90	0.3
	13	0	2200	19.5
		100	2970	26.3
		300	3400	30.2
		500	2480	22.0
		1000	225	2.0
	14	10	7450	42.0
		100	10300	58.0
P-6701	1	0	690	15.0
		530	3480	75.6
		845	112	2.4
		1250	23	0.5
		1725	280	6.1
		2425	20	0.4
	2	0	170	0.9
		90	7860	42.1
		220	705	3.8
		350	9740	52.1

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		500	134	0.7
		575	76	0.4
	3	0	130	2.3
		115	1090	19.1
		250	2150	37.7
		350	1290	22.6
		435	678	11.9
		750	272	4.8
		970	90	1.6
	4	0	140	29.2
		130	1	0.2
		505	220	45.8
		1000	65	13.5
		1338	35	7.3
		2500	12	2.5
		3500	7	1.5
	5	0	5650	19.7
		90	17800	62.2
		250	2810	9.8
		504	2040	7.1
		860	246	0.9
		1000	64	0.2
		1830	10	0.0
	8	0	1650	9.5
		70	51	0.3
		250	9900	56.9
		505	4730	27.2
		817	870	5.0
		955	154	0.9
		1625	55	0.3
	10	0	192	1.8
		110	6500	60.5
		500	378	3.5
		1000	1660	15.5
		1800	1120	10.4
		2200	188	1.8
		2850	699	6.5

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	11	0	94	0.7
		110	9300	67.1
		500	3460	25.0
		975	394	2.8
		1525	105	0.8
		1800	46	0.3
		2375	465	3.4
	12	0	440	1.9
		100	18600	79.2
		500	3860	16.4
		920	320	1.4
		1450	93	0.4
		1825	40	0.2
		2450	85	0.4
		3100	22	0.1
		3200	11	0.0
	13	0	28700	48.5
		100	12600	21.3
		450	16700	28.2
		1000	935	1.6
		1500	155	0.3
		1950	4	0.0
		3100	20	0.0
		3200	14	0.0
	14	0	25900	48.8
		100	26900	50.7
		500	90	0.2
		1000	13	0.0
		1650	60	0.1
		2150	32	0.1
		2375	10	0.0
		3850	4	0.0
		4350	30	0.1
	16	0	2640	36.8
		100	3460	48.2
		398	969	13.5
		775	68	0.9

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1250	45	0.6
	18	0	4350	14.6
		100	18000	60.5
		500	7240	24.3
		1000	20	0.1
		1625	44	0.1
		2200	41	0.1
		2650	22	0.1
		3800	19	0.1
		4350	31	0.1
	20	0	1	0.0
		100	4	0.0
		250	13200	98.3
		450	8	0.1
		850	59	0.4
		1050	117	0.9
		1500	42	0.3
	22	0	980	6.0
		100	6810	42.0
		475	7650	47.1
		1000	564	3.5
		1650	89	0.5
		2000	64	0.4
		2350	73	0.4
	24	0	9950	30.1
		100	17500	52.8
		500	5480	16.6
		1000	133	0.4
		1800	7	0.0
		2600	33	0.1
		3000	14	0.0
G-6722	4	0	13000	53.5
		55	11100	45.7
		335	115	0.5
		581	26	0.1
		1040	7	0.0

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1520	51	0.2
	9	0	15100	68.7
		40	3700	16.8
		155	1530	7.0
		320	1580	7.2
		562	8	0.0
		875	27	0.1
		1200	35	0.2
	10	0	2750	59.4
		45	380	8.2
		225	290	6.3
		405	867	18.7
		630	224	4.8
		824	20	0.4
		1800	55	1.2
		3000	3	0.1
		3500	34	0.7
		4500	8	0.2
	12	0	16800	42.0
		80	21500	53.7
		181	1370	3.4
		310	230	0.6
		675	108	0.3
		1150	9	0.0
	15	0	580	49.1
		30	390	33.0
		132	87	7.4
		240	32	2.7
		450	38	3.2
		635	54	4.6
	17	0	1080	24.4
		55	520	11.8
		250	2470	55.8
		525	177	4.0
		1000	34	0.8
		1500	60	1.4
		2000	83	1.9

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
P-6803	4	0	1020	12.5
		30	5650	69.4
		100	1470	18.1
	5	0	17000	30.5
		40	38700	69.5
	8	0	3820	3.7
		40	72700	70.2
		95	15800	15.2
		175	11300	10.9
	11	0	1640	14.1
		30	6550	56.2
		580	2430	20.8
		1030	522	4.5
		1500	182	1.6
		2000	53	0.5
		2500	284	2.4
	15	0	2020	4.8
		100	27000	64.7
		200	6380	15.3
		400	5970	14.3
		750	157	0.4
		995	211	0.5
		1200	13	0.0
	16	0	2940	62.7
		100	1180	25.2
		225	18	0.4
		420	288	6.1
		1000	223	4.8
		1500	27	0.6
		3000	10	0.2
	17	0	7650	28.7
		100	660	2.5
		240	1120	4.2
		490	16500	62.0
		1000	423	1.6
		2200	253	1.0
		3000	9	0.0

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	18	0	3000	22.1
		100	5440	40.0
		245	3120	22.9
		480	1210	8.9
		1000	612	4.5
		1500	147	1.1
		2150	21	0.2
		2200	16	0.1
		3500	34	0.2
	20	0	35	0.3
		75	3460	27.0
		125	3440	26.9
		235	2750	21.5
		475	2510	19.6
		740	615	4.8
	22	0	210	0.6
		100	8300	22.9
		200	9540	26.3
		470	17500	48.3
		890	354	1.0
		1650	258	0.7
		3000	51	0.1
	25	0	1620	7.2
		100	53	0.2
		250	17500	78.2
		500	1850	8.3
		750	606	2.7
		1000	491	2.2
		1425	264	1.2
	26	0	44	0.3
		100	7160	44.4
		150	48	0.3
		480	8640	53.6
		750	186	1.2
		1000	40	0.2
P-6805	2	0	1900	12.2

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		100	8750	56.2
		250	3880	24.9
		440	15	0.1
		715	970	6.2
		1000	10	0.1
		1500	55	0.4
	3	0	13600	30.5
		100	14200	31.8
		250	9260	20.7
		500	7440	16.7
		1040	20	0.0
		1583	15	0.0
		2250	15	0.0
		2400	82	0.2
	4	0	8050	37.2
		90	3050	14.1
		500	10300	47.6
		1010	100	0.5
		1500	16	0.1
		2000	115	0.5
		2323	3	0.0
		3350	2	0.0
		4000	8	0.0
	5	0	3950	17.1
		96	960	4.1
		250	6680	28.9
		340	11500	49.6
		500	76	0.3
		770	4	0.0
	7	0	900	3.1
		50	28200	95.7
		1000	330	1.1
		1500	9	0.0
		2300	10	0.0
		2650	4	0.0
	9	0	1050	8.4
		65	4550	36.4

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		250	2520	20.2
		500	4280	34.2
		1438	10	0.1
		2026	87	0.7
	10	0	350	4.4
		55	550	6.8
		245	2400	29.9
		477	4360	54.2
		995	320	4.0
		1500	13	0.2
		2256	38	0.5
		2500	9	0.1
	11	0	150	2.5
		250	4400	72.4
		537	200	3.3
		1050	750	12.3
		1700	480	7.9
		2263	39	0.6
		2550	39	0.6
		4517	16	0.3
P-6811	1	0	7150	25.9
		38	7450	27.0
		250	6480	23.5
		500	6460	23.4
		750	10	0.0
		950	10	0.0
		2025	14	0.1
	2	0	240	1.3
		77	2950	16.2
		237	11300	62.0
		508	2030	11.1
		822	1540	8.4
		1000	164	0.9
		1200	14	0.1
	3	0	25200	92.1
		63	4	0.0

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		225	1170	4.3
		500	560	2.0
		770	376	1.4
		1450	30	0.1
		1800	7	0.0
	4	0	13900	29.3
		50	29200	61.6
		270	440	0.9
		550	3240	6.8
		1050	195	0.4
		1800	101	0.2
		2150	4	0.0
		2312	89	0.2
		3000	84	0.2
		3250	159	0.3
	5	0	10200	33.4
		25	12700	41.6
		250	2900	9.5
		500	4600	15.1
		750	8	0.0
		1016	11	0.0
		1823	39	0.1
		2450	16	0.1
		2850	59	0.2
	6	0	7850	32.6
		25	6250	26.0
		250	4960	20.6
		485	3780	15.7
		720	910	3.8
		1000	15	0.1
		1750	23	0.1
		2025	283	1.2
		2525	9	0.0
	7	0	1530	4.4
		90	5240	15.0
		125	220	0.6
		225	4700	13.4

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		275	8580	24.5
		375	10500	30.0
		500	4270	12.2
	8	0	600	6.9
		27	560	6.5
		238	4060	46.9
		480	450	5.2
		713	1270	14.7
		1000	1090	12.6
		1500	540	6.2
		2000	79	0.9
		2450	5	0.1
	9	0	500	1.0
		50	24600	51.2
		230	18200	37.8
		450	65	0.1
		635	4420	9.2
		875	18	0.0
		1400	11	0.0
		1525	270	0.6
		2350	4	0.0
	10	0	1500	3.7
		25	15100	37.7
		250	15900	39.7
		500	6360	15.9
		750	5	0.0
		900	5	0.0
		1000	1210	3.0
	11	0	20400	55.6
		45	4450	12.1
		285	6750	18.4
		590	4050	11.0
		800	40	0.1
		1200	11	0.0
		1400	1010	2.8
	12	0	4800	14.0
		35	22700	66.2

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		160	1490	4.3
		290	4740	13.8
		550	30	0.1
		775	352	1.0
		1100	188	0.5
	14	0	4950	61.8
		40	1550	19.3
		285	820	10.2
		590	340	4.2
		800	185	2.3
		1175	3	0.0
		1700	75	0.9
		1875	30	0.4
		2375	7	0.1
		2850	55	0.7
	15	0	7400	52.2
		55	620	4.4
		237	5910	41.7
		470	5	0.0
		1000	118	0.8
		1325	74	0.5
		1500	6	0.0
		1950	58	0.4
	16	0	4300	28.4
		52	6000	39.7
		250	4240	28.0
		500	56	0.4
		750	185	1.2
		1000	190	1.3
		1500	70	0.5
		2150	41	0.3
		2550	31	0.2
	17	0	1080	4.2
		85	16500	64.5
		237	3210	12.5
		485	3940	15.4
		714	14	0.1

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1000	700	2.7
		1500	51	0.2
		1950	43	0.2
		2375	25	0.1
		3500	27	0.1
	18	0	17700	52.3
		114	5450	16.1
		260	3870	11.4
		525	6140	18.1
		763	440	1.3
		1050	192	0.6
		1500	12	0.0
		1900	4	0.0
		2500	52	0.2
		3500	14	0.0
	19	0	12300	57.8
		75	31	0.1
		320	8250	38.8
		700	330	1.6
		800	116	0.5
		1250	82	0.4
		1500	1	0.0
		1625	41	0.2
		1850	59	0.3
		2350	64	0.3
	20	0	1710	21.4
		75	1250	15.7
		250	46	0.6
		500	3900	48.9
		750	1010	12.7
		1000	67	0.8
P-6904	1	0	2850	51.4
		38	1800	32.4
		215	34	0.6
		415	850	15.3
		795	2	0.0

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1125	13	0.2
	2	0	15300	55.2
		14	6350	22.9
		265	3160	11.4
		500	2130	7.7
		1150	780	2.8
	3	0	8600	54.5
		30	2100	13.3
		265	4470	28.3
		550	450	2.9
		800	3	0.0
		1050	6	0.0
		1700	146	0.9
		2000	5	0.0
		2250	1	0.0
	4	0	3570	16.9
		30	450	2.1
		230	7200	34.2
		470	9750	46.3
		950	23	0.1
		1400	2	0.0
		1925	29	0.1
		2380	1	0.0
		3410	4	0.0
		3560	55	0.3
	5	0	3870	16.1
		21	3250	13.5
		250	14000	58.1
		500	2540	10.5
		1033	295	1.2
		1534	2	0.0
		2000	23	0.1
		2620	16	0.1
		3655	19	0.1
		4105	65	0.3
	6	0	1250	7.5
		31	1280	7.7

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		232	13800	82.7
		418	15	0.1
		1000	21	0.1
		1500	68	0.4
		2042	36	0.2
		2575	15	0.1
		3144	154	0.9
		3594	37	0.2
		4000	3	0.0
	7	0	50	1.0
		25	1150	23.8
		241	1920	39.7
		452	170	3.5
		637	620	12.8
		918	870	18.0
		1404	54	1.1
	9	0	85	0.4
		70	700	3.4
		236	8130	40.0
		467	9990	49.2
		676	1100	5.4
		1000	300	1.5
	10	0	69	0.9
		30	570	7.8
		233	650	8.9
		455	2810	38.6
		663	1340	18.4
		981	1030	14.2
		1484	380	5.2
		1892	117	1.6
		2394	312	4.3
	11	0	12300	54.3
		45	5950	26.3
		262	460	2.0
		524	3310	14.6
		759	435	1.9
		1036	198	0.9

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		1125	13	0.2
	2	0	15300	55.2
		14	6350	22.9
		265	3160	11.4
		500	2130	7.7
		1150	780	2.8
	3	0	8600	54.5
		30	2100	13.3
		265	4470	28.3
		550	450	2.9
		800	3	0.0
		1050	6	0.0
		1700	146	0.9
		2000	5	0.0
		2250	1	0.0
	4	0	3570	16.9
		30	450	2.1
		230	7200	34.2
		470	9750	46.3
		950	23	0.1
		1400	2	0.0
		1925	29	0.1
		2380	1	0.0
		3410	4	0.0
		3560	55	0.3
	5	0	3870	16.1
		21	3250	13.5
		250	14000	58.1
		500	2540	10.5
		1033	295	1.2
		1534	2	0.0
		2000	23	0.1
		2620	16	0.1
		3655	19	0.1
		4105	65	0.3
	6	0	1250	7.5
		31	1280	7.7

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		232	13800	82.7
		418	15	0.1
		1000	21	0.1
		1500	68	0.4
		2042	36	0.2
		2575	15	0.1
		3144	154	0.9
		3594	37	0.2
		4000	3	0.0
	7	0	50	1.0
		25	1150	23.8
		241	1920	39.7
		452	170	3.5
		737	620	12.8
		918	870	18.0
		1404	54	1.1
	9	0	85	0.4
		70	700	3.4
		236	8130	40.0
		467	9990	49.2
		676	1100	5.4
		1000	300	1.5
	10	0	69	0.9
		30	570	7.8
		233	650	8.9
		455	2810	38.6
		663	1340	18.4
		981	1030	14.2
		1484	380	5.2
		1892	117	1.6
		2394	312	4.3
	11	0	12300	54.3
		45	5950	26.3
		262	460	2.0
		524	3310	14.6
		759	435	1.9
		1036	198	0.9

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CARIBBEAN ZOOPLANKTON. PART I. SIPHONOPHORA, HETEROPODA, COPEPO--ETC (U)
JUN 76 H B MICHEL, M FOYO, D A HAAGENSEN N00014-67-A-0201-0013

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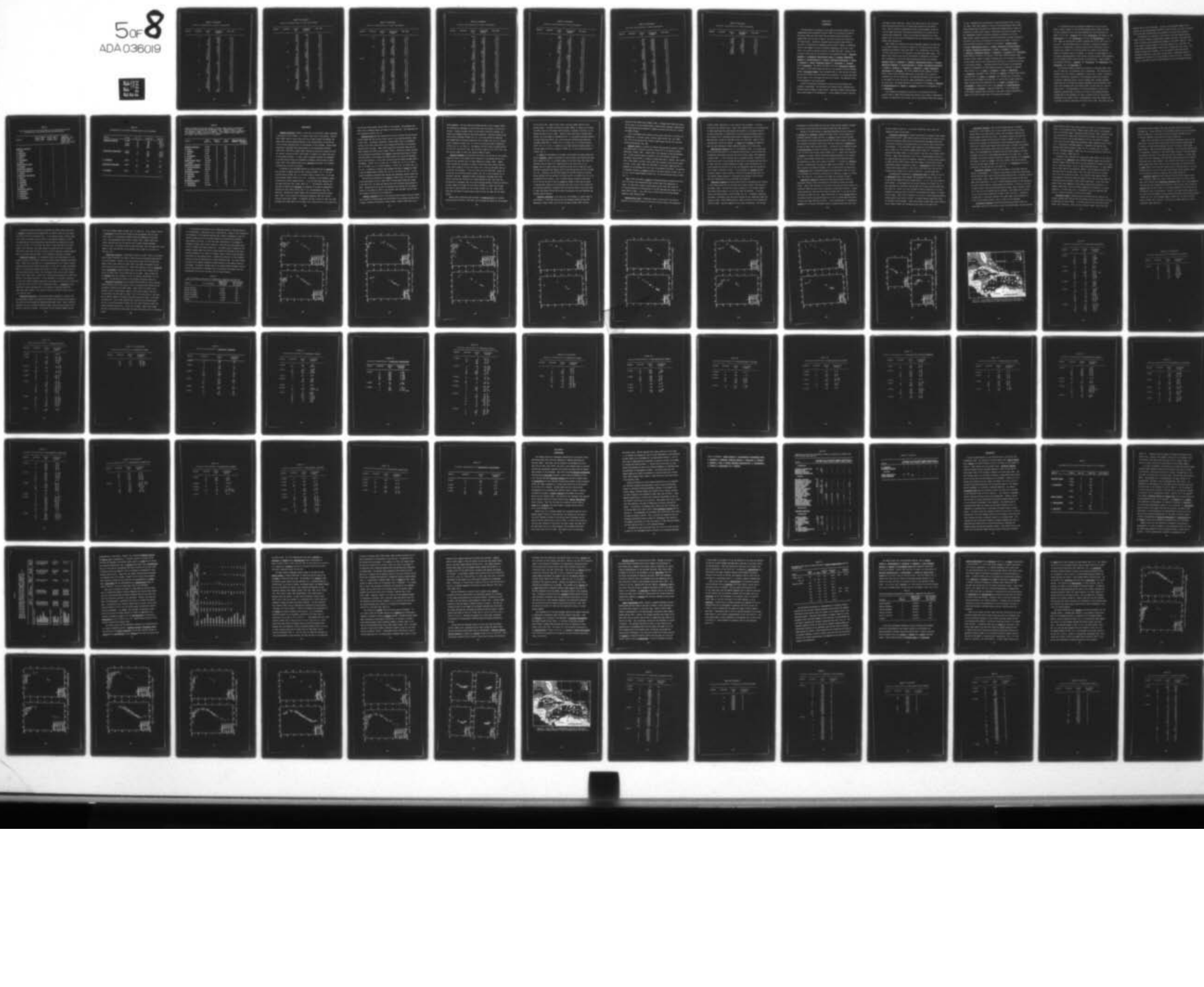

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1.0 1.1 1.25 1.4 1.6 1.8 2.0 2.2 2.5 2.8 3.2 3.6 4.0 4.5 5.0 5.6 6.3

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	12	0	2130	16.7
		30	8350	65.6
		259	810	6.4
		515	1030	8.1
		781	335	2.6
		1036	75	0.6
	13	0	405	6.9
		48	1250	21.4
		258	470	8.1
		524	3190	54.6
		753	330	5.7
		1019	110	1.9
		1638	17	0.3
		2115	38	0.7
		2612	21	0.4
		3474	7	0.1
	14	0	15	0.2
		37	1380	21.3
		239	4770	73.5
		458	50	0.8
		734	85	1.3
		1052	46	0.7
		1454	70	1.1
		1828	63	1.0
		2336	15	0.2
	15	0	770	7.2
		52	3550	33.2
		261	2040	19.1
		524	4220	39.4
		791	36	0.3
		1057	74	0.7
		1500	4	0.0
		1816	2	0.0
		2248	15	0.1
		3288	1	0.0
	16	0	102	2.3
		59	3480	77.9

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		253	840	18.8
		519	16	0.4
		761	1	0.0
		974	18	0.4
		1500	11	0.2
	17	0	310	4.3
		45	980	13.6
		251	4660	64.5
		750	755	10.4
		971	501	6.9
		1408	20	0.3
	18	0	105	0.7
		62	1220	8.0
		261	4830	31.8
		531	8300	54.7
		802	320	2.1
		1033	134	0.9
		1532	4	0.0
		1747	101	0.7
		1942	37	0.2
		2540	127	0.8
	19	0	670	7.3
		30	5100	55.4
		274	2820	30.7
		550	410	4.5
		904	135	1.5
		1248	18	0.2
		1583	22	0.2
		1986	16	0.2
		2524	8	0.1
	20	0	220	3.2
		10	6050	87.9
		258	44	0.6
		537	366	5.3
		827	195	2.8
		1052	1	0.0
		1588	9	0.1

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
	21	0	275	0.8
		50	6050	17.7
		220	21400	62.7
		297	6380	18.7
		431	24	0.1
		490	21	0.1
	22	0	460	2.1
		40	4950	22.5
		252	4620	21.0
		372	2520	11.4
		450	6300	28.6
		554	3140	14.3
		620	20	0.1
P-6911	1	0	1230	3.0
		65	17900	43.7
		250	16900	41.3
		459	3440	8.4
		715	387	0.9
		911	777	1.9
		1371	130	0.3
		1835	54	0.1
		2337	130	0.3
	2	0	3350	13.6
		53	7350	29.8
		242	9660	39.2
		533	4080	16.6
		844	13	0.1
		1272	174	0.7
	3	0	113	0.4
		60	14100	55.8
		274	7700	30.5
		494	830	3.3
		739	936	3.7
		1040	1380	5.5
		1567	93	0.4
		2072	125	0.5

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		2556	8	0.0
	4	0	460	5.0
		81	1950	21.3
		218	1620	17.7
		423	4600	50.2
		836	470	5.1
		1338	30	0.3
		1844	38	0.4
	5	0	160	0.7
		59	360	1.7
		237	15100	69.3
		472	4060	18.6
		698	139	0.6
		996	1730	7.9
		1878	204	0.9
		2474	49	0.2
	6	0	1040	6.8
		50	7900	51.4
		240	25	0.2
		481	5200	33.8
		665	234	1.5
		888	158	1.0
		1324	825	5.4
	7	0	20	0.1
		60	460	2.4
		253	9150	47.6
		539	6540	34.0
		779	2310	12.0
		1000	83	0.4
		1300	658	3.4
	8	0	156	0.8
		60	7550	40.0
		243	7080	37.5
		510	3180	16.8
		995	54	0.3
		1548	296	1.6
		2088	212	1.1
		2316	346	1.8

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		3304	10	0.1
		3942	12	0.1
	9	0	1250	5.7
		60	2250	10.2
		250	16300	74.0
		515	930	4.2
		1006	237	1.1
		1580	702	3.2
		2088	38	0.2
		2454	143	0.6
		3442	155	0.7
		3910	17	0.1
	10	0	1100	3.2
		56	11800	34.0
		227	15500	44.6
		480	4540	13.1
		975	378	1.1
		1500	286	0.8
		2032	13	0.0
		2118	648	1.9
		2660	439	1.3
		3176	45	0.1
	11	0	3650	19.7
		58	4500	24.3
		234	8820	47.5
		491	245	1.3
		969	231	1.2
		1570	440	2.4
		2104	134	0.7
		2490	267	1.4
		3602	222	1.2
		4096	41	0.2
	12	0	192	0.5
		36	860	2.1
		78	1840	4.5
		153	3620	8.8
		200	292	0.7

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		258	615	1.5
		296	13200	32.1
		344	7840	19.1
		410	5980	14.6
		465	6630	16.1
	13	0	3850	14.3
		65	18500	68.5
		269	3110	11.5
		500	1110	4.1
		1036	16	0.1
		1601	224	0.8
		2232	36	0.1
		2862	92	0.3
		5200	77	0.3
	14	0	1320	9.2
		34	11800	82.3
		265	13	0.1
		520	346	2.4
		785	545	3.8
		954	196	1.4
		1443	121	0.8
	15	0	3180	12.4
		53	8320	32.4
		224	12800	49.8
		445	140	0.5
		970	912	3.5
		1424	53	0.2
		1998	37	0.1
		2950	75	0.3
		3932	103	0.4
		4556	21	0.1
		6220	14	0.1
		7000	9	0.0
		7500	42	0.2
	16	0	2340	8.3
		51	15800	56.3
		243	9640	34.4

TABLE 57 (continued)

Vertical distribution of other Cyclopoida

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER	PER CENT
		478	39	0.1
		1012	32	0.1
		1525	46	0.2
		2032	163	0.6
	17	0	440	2.8
		54	6300	39.5
		261	8310	52.1
		514	260	1.6
		1039	546	3.4
		1590	24	0.2
		2216	71	0.4

Euphausiacea

Introduction

The broad areas of occurrence of each species have been outlined in the comprehensive work of Mauchline & Fisher (1969), who included the records of Tattersall (1926) and Lewis (1954) from the Florida Straits and those of Legaré (1961) from the Gulf of Cariaco, the Gulf of Paria and the waters off the Orinoco Delta. Additional information was provided by James (1970) in his report on collections of euphausiids from the Gulf of Mexico, by Björnberg (1971) in her summary of works on Caribbean zooplankton, and by Owre & Foyo (1972), who listed the species collected on P-6602 (Table 58). Fifteen of the 23 species listed here are new records for the Caribbean Sea proper: *Euphausia hemigibba*, *E. pseudogibba*, *Nematobrachion boopis*, *N. flexipes*, *Nematoscelis megalops*, *N. microps/atlantica*, *N. tenella*, *Stylocheiron abbreviatum*, *S. affine*, *S. carinatum*, *S. suhmii*, *Thysanopoda aequalis*, *T. obtusifrons*, *T. pectinata* and *T. tricuspidata*. One species included in the list, *Stylocheiron elongatum*, was caught in the Florida Straits and has yet to be reported from the Caribbean. Another, *Nyctiphanes simplex*, found by Legaré (1961) in both the Gulf of Cariaco and the Gulf of Paria and a new record for the Atlantic, is a coastal form which did not appear in our collections and thus is not listed. The euphausiid fauna of the Caribbean is very poorly known.

Records of horizontal distribution of species are often disjunct and difficult to understand. The literature also contains broad, sometimes quite different vertical ranges for many species. Some make extensive vertical migrations, others appear to be non-migratory. Strong swimmers as adults, they may

avoid small, slowly towed nets. Most of the older records in the literature have been derived from vertical or oblique tows of meter nets and smaller sizes. Data on catches on euphausiids in meter nets and midwater trawls provided by James (1970) amply illustrate the inefficiency of the meter net in catching adult euphausiids. Seven of the 30 species appeared only in trawl samples, and the trawl collected euphausiids far more frequently and in greater numbers than the meter net.

Baker (1970), Roe (1972a-d) and others repeatedly sampled in an area east of the Canary Islands, using first a ring net of 1 m^2 mouth area and later an opening-closing midwater trawl system (RMT 1 + 8), consisting of one net with 1 m^2 mouth area and one of 8 m^2, mounted in the same frame (Baker *et al.*, 1973). Baker's work (1970) on the vertical distribution of euphausiids in the upper 950 m included data on 16 of the species reported here from the Caribbean: *Euphausia brevis*, *E. gibboides*, *E. hemigibba*, *Nematobrachion boopis*, *N. flexipes*, *Nematoscelis megalops*, *N. microps/atlantica*, *N. tenella*, *Stylocheiron abbreviatum*, *S. affine*, *S. carinatum*, *S. elongatum*, *S. longicorne*, *S. suhmii*, *Thysanopoda obtusifrons* and *T. pectinata*. Roe (1974) examined diurnal changes in distribution of many forms, including euphausiids, in the upper 250 m, using the combination net for his collections. The analyses were mainly based on catches of the smaller net since the big net caught siphonophores, decapods, fishes and little else. Roe added information on the behavior of *E. brevis*, *E. hemigibba*, *N. microps/atlantica*, *N. tenella*, *S. elongatum*, described as non-migratory, and *T. obtusifrons*.

In an extensive investigation carried out in the equatorial and south tropical Pacific, Roger (1974) studied many aspects of the biology of euphausiids living in the upper 800 m with the major aim of understanding trophic webs leading

to tuna. Specimens were collected with a neuston net (David, 1965), a larval net (Omori, 1965) and, primarily, a 10-foot Isaacs-Kidd midwater trawl (IKMT). Roger estimated that less than 1% of euphausiids averaging 10 mm in length are retained by the IKMT, which, however, satisfactorily collects the larger forms. The zoogeography, spatial distribution (swarming), differences in day and night catches, seasonal variations, vertical distributions, ecology, reproduction and growth, and trophic relationships of 34 species are treated. Fifteen of these are among the species collected in the Caribbean: Euphausia brevis, E. mutica, Nematobrachion boopis, N. flexipes, Nematoscelis microps/atlantica, N. tenella, Stylocheiron abbreviatum, S. affine, S. carinatum, S. elongatum, S. longicorne, Thysanopoda aequalis, T. monacantha, T. pectinata and T. tricuspidata. Having based his studies on collections of more than 400,000 specimens, Roger was able to make a number of summary statements about the occurrence of euphausiids in the tropical Pacific, which should apply equally well to populations occurring in the tropical Atlantic. Concerning vertical distributions, he distinguished a group of non-migratory or feebly migratory species, consisting of epipelagic forms (0-300 m, e.g., S. suhmii, S. carinatum, S. affine, S. abbreviatum, S. longicorne), mesopelagic forms (160-500 m, N. tenella), and deep-living species (more than 300 m, N. boopis, S. elongatum), and a second group of migrating species which are abundant only below 300 m in the day and at night concentrate almost entirely above the thermocline (e.g., E. tenera, T. aequalis and T. tricuspidata) or remain partly below it (N. flexipes, N. microps/atlantica, T. monacantha, T. pectinata). Roger also found that, "in the oligotrophic south tropical regions, where the water is very clear, vertical distributions appear to be 50-150 m deeper than in the equatorial divergence."

It is interesting that the percentage composition of the five major genera in Roger's sample of over 400,000 specimens, mostly caught with IKMT, is almost duplicated in our collection numbering only 26,729 specimens and caught in 3/4 m nets: Euphausia, 63% in both; Stylocheiron, 25% (Roger) vs. 29%; Nematoscelis, 9 vs. 3.4%; Thysanopoda 3% in both; and Nematobrachion, 0.4 vs. 1.3%. Roger was dealing with 34 species compared with our 23, and 19 occur in both areas. The percentages appear to illustrate a consistency of generic composition of euphausiids in tropical oceans which is sufficiently basic to supercede the variables of collecting method, size ranges of the organisms caught, net avoidance and size of sample. In contrast, the percentages of the five genera comprising Baker's (1970) smaller collections (total, 8255 specimens) from the temperate eastern North Atlantic off Fuerteventura , Canary Islands, are altogether different: Euphausia, 21%; Stylocheiron, 31%; Nematoscelis, 31%; Thysanoessa, 12%; and Thysanopoda, 5%.

The Caribbean samples, having been obtained with relatively small, horizontally towed nets, are predictably poor in euphausiids. Tows were made upon reaching the station position, regardless of time of day or night. The data on vertical distribution, expressed in T-S-P diagrams, mainly bear out Roger's conclusions, summarized earlier, and his statement that, "broadly speaking, Euphausiids can be considered as largely independent from environmental conditions, whose influence upon their distributions is obvious only on a very extensive scale." The relationship of vertical distribution to time of day remarkably parallels Roger's records in the case of most migrating species. Although GMT is used throughout for times of towing as well as collection of hydrographic data (Tables 13-20), an approximation of the local apparent time can quickly be made by subtracting five hours from the GMT. This gives the local

apparent time on the 75°W meridian. Actually, the latitudinal spread of the stations in this study extends from 59°33'W, where the time is 3 hours, 58 minutes earlier than GMT to 88°29'W where the difference is 5 hours and 54 minutes.

In analyzing the collections, total counts of the less numerous species (Table 59) and of samples containing few specimens were made. The latter plus counts of aliquots gave estimated total numbers of the others (Table 60). Thus, in the tables listing occurrence of individual species (e.g., Table 62), the column headed "Estimated Number" almost always includes some total counts. The presence of males and/or females, as well as immature forms which could be accurately identified is also noted in these tables. Unidentified immature specimens were included in the total figures in Tables 23 and 61. The distribution of each species will be treated separately in the following discussion.

TABLE 58

Previous records from the Gulf of Mexico, the Florida Straits and the Caribbean Sea of the euphausiid species reported here.

Species	Gulf of Mexico (James, 1970; Moore, 1952)	Florida Straits (Lewis, 1954; Stepien, 1976)	Caribbean (Björnberg, 1971; Hansen, 1915; Legaré, 1961; Owre & Foyo, 1972)
Euphausia americana	+	+	+
E. brevis	+	+	+
E. gibboides	+	+	-
E. hemigibba	+	+	-
E. mutica	+	+	+
E. pseudogibba	+	+	-
E. tenera	+	+	+
Nematobrachion boopis	+	+	-
N. flexipes	+	+	-
Nematoscelis megalops	+	+	+
N. microps/atlantica	+	+	-
N. tenella	+	+	-
Stylocheiron abbreviatum	+	+	-
S. affine	+	-	-
S. carinatum	+	+	+
S. elongatum	+	+	-
S. longicorne	+	+	+
S. suhmii	+	+	+
Thysanopoda aequalis	+	-	+
T. monacantha	+	+	+
T. obtusifrons	+	+	-
T. pectinata	+	-	-
T. tricuspidata	+	+	-

TABLE 59

Distribution of five rarely collected species in the Caribbean.

Species	Cruise	Sta. No.	Depth (m)	Total No.
Euphausia gibboides	P-6606	8	100	60♀
		14	100	190♂♀
	P-6803	17	100	6♂♀
	P-6911	10	227	53♂♀
		11	2490	1♂
Stylocheiron abbreviatum	P-6805	5	250	8♂♀
	P-6904	7	241	4♂♀
		21	220	14♂♀
			297	9♂♀
S. elongatum	P-6904	22	372	5♀
Thysanopoda monacantha	P-6803	17	240	1♂
		18	480	5♀
T. pectinata	P-6911	10	2660	1♀

TABLE 60

Relative abundance and vertical range of the more common species of euphausiids collected in the Caribbean Sea and adjacent areas. Species ranked as 1 were most frequently caught, in 35 to 45 samples. Those ranked as 2 were intermediate in frequency of capture, having occurred in 15 to 19 samples. Those ranked as 3 were caught least frequently, in 6 to 11 samples.

Species	Total Range (m)	Number of Samples	Total Numbers	Rank in Order of Abundance	Rank in Order of Frequency of Capture
Euphausia americana	0-2500	41	2891	3	1
E. brevis	0-1878	35	4955	2	1
E. hemigibba	53-590	16	585	9	2
E. mutica	0-500	19	1255	7	2
E. pseudogibba	55-550	11	46	18	3
E. tenera	0-1000	43	6789	1	1
Nematobrachion boopis	420-1000	11	165	16	3
N. flexipes	45-2454	8	179	15	3
Nematoscelis megalops	200-593	8	240	13	3
N. microps/atlantica	132-781	17	406	11	2
N. tenella	218-590	10	260	12	3
Stylocheiron affine	0-265	16	1720	6	2
S. carinatum	0-285	15	2845	4	2
S. longicorne	0-1638	45	2416	5	1
S. suhmii	38-115	8	875	8	3
Thysanopoda aequalis	0-1272	17	461	10	2
T. obtusifrons	55-550	6	230	14	3
T. tricuspidata	372-2660	7	54	17	3

Distribution

Euphausia americana is known to occur only in the Atlantic, where, according to Mauchline & Fisher (1969), it is usually found close to the surface. However, Moore (1949) found it mostly below 300 m and in small numbers off Bermuda, and Lewis (1954) reported maximum abundance in the Florida Straits at 250-300 fms. Little has been published about its distribution in the Caribbean. Hansen (1915) identified 11 specimens from surface waters in the southeastern Caribbean (10°51'30"N, 67°01'40"W), Legaré (1961) reported six from tows between 300 m and the surface, and Owre and Foyo (1972) found it "present" in a sample from 435 m in the eastern Caribbean. In their study of seasonal variation of zooplankton in surface waters entering the Caribbean at Barbados, based entirely on night hauls, Lewis & Fish (1969) stated that *E. americana* was present in all samples collected over a period of 24 months.

In addition to the Caribbean material now being considered, *E. americana* also occurred in samples from the Gulf of Mexico (P-6803 , Sta. 4, 11), the Florida Straits (P-6901, Sta. 1), the North Atlantic (P-6911, Sta. 14, 16) and the Old Bahama Channel (P-6911, Sta. 17). It appears to be an abundant, widely distributed but poorly sampled species. It was the third most numerous form and among those most often caught (Table 60). The extensive vertical distribution recorded for *E. americana*, the greatest in our data on euphausiids, indicates,as Lewis (1954) showed, that it is a strong migrator (Fig. 27A, Table 62). Although the largest numbers were collected from Tropical Surface Water (TSW), it also occurred in Subtropical Underwater (SUW) and in North Atlantic Central Water (NACW). To summarize the data in Table 62, 78% of the 2891 specimens were caught above 55 m at night, 5.5% at dawn and dusk in the upper 40 m,

and 16% were found between 250 and 2500 m in the daytime. The specimens from 2500 m were 12 immature males and unique in the collections. The remaining 0.5% were exceptions (P-6911, Sta. 2).

Euphausia brevis has been reported from the Gulf of Mexico and the Florida Straits (Table 58) and from one surface station in the eastern Caribbean (Owre & Foyo, 1972). According to Mauchline & Fisher (1969), this is a widespread species in the three oceans which occurs between 300 and 500 m in the daytime and above 100 m at night. Baker (1970) found that the daytime range off the Canary Islands was 90-570 m and at night, 0-960 m. Mauchline & Fisher referred to the horizontal distribution of E. brevis as associated with areas of depths less than 4000 m in the Atlantic and Indian oceans, but in both the Caribbean and the North Atlantic, it was often collected where the depths exceeded 4000 m (Caribbean: P-6701, Sta. 4; G-6722, Sta. 4; P-6805, Sta. 9, 10, 11; P-6811, Sta. 17; P-6904, Sta. 6, 13; North Atlantic: G-6722, Sta. 10; P-6911, Sta. 13, 15, 16). In addition to Atlantic and Caribbean stations, E. brevis was caught in the Old Bahama Channel (P-6904, Sta. 20, 21, 22; P-6911, Sta. 17). It was second in abundance and among those species most frequently captured (Table 60).

The vertical distribution of E. brevis is shown in Fig. 27B and Table 63. It was found mainly in TSW at night, 89% of the specimens having been caught in the upper 50 m, but males and females also were collected during daytime in NACW. Although there are no data on temperature and salinity for the deepest record, of two females at 1878 m, they probably came from NADW, the data from 996 m being 4.7°C and 34.91 ‰ (Table 20).

Euphausia gibboides occurs in the western Atlantic between 10°N and 40-45°N, and it usually is found between 280 and 700-800 m in the daytime and above 280 m at night, according to Mauchline & Fisher (1969). Baker's (1970) data are in

broad agreement. The only previous Caribbean record is that of Legaré (1961), who collected two specimens in shallow water near the entrance to the Gulf of Cariaco. During the present study, it was found at only five stations, all within the Caribbean (Table 59) and widely separated. They are situated in the south central Caribbean (P-6606, Sta. 8), in an area affected by upwelling near Panama where the bottom sounding was 219 m (P-6606, Sta. 14), at a station north of Honduras (P-6803, Sta. 17), and at two locations south of Hispaniola (P-6911, Sta. 10, 11) (Fig. 9). The samples from 100 m were all taken from SUW (21.3-24.2°C, 36.67-36.73 °/oo), that from 227 m, NACW (17.1°C, 36.29 °/oo), and the one male caught at 2490 m was living in NADW (no data).

Euphausia hemigibba is distributed from 45°N to the latitude of the northern Venezuelan coast in the Atlantic and is reported to live between 280 and 700 m during the day and above 140 m at night (Mauchline & Fisher, 1969). Legaré (1961) reported two specimens in a 200-0 m tow off the Orinoco Delta, and Owre & Foyo (1972) caught it at 500 m off Brazil, but it has not previously been recorded from the Caribbean. It was not found to be rare (Table 60). Except for one station in the Florida Straits (P-6904, Sta. 22), it was collected only at Caribbean locations. Regarding vertical distribution, specimens were found either in TSW and SUW (53-100 m) or in NACW (300-590 m) (Fig. 28A, Table 64). The majority of specimens, 59%, was collected during daytime at depths of 350-510 m; 21% were caught in the upper 90 m and 10% at 300-590 m at night; and 10% came from 100 m at dusk (P-6606, Sta. 8) and dawn (P-6803, Sta. 16). Baker (1970) found that the species occupies deeper levels both day and night off the Canary Islands.

Hansen (1915) identified eight specimens of Euphausia mutica in a surface collection from 10°51'30"N, 67°01'40"W, thus recording the species in the Caribbean

for the first time. Legare (1961) found it the most common species in the Cariaco region. According to Mauchline & Fisher (1969), it tends to live inside the 4000 m contour in the western North Atlantic, at depths of 140-700 m in the daytime and above 100 m at night. Legaré's report would tend to confirm this; however, the total number of specimens was 26. In the present Caribbean material, its depth range was 0-500 m, and it was collected in several areas where the soundings exceed 4000 m (P-6701, Sta. 13; P-6911, Sta. 9, 11; North Atlantic: P-6911, Sta. 13, 14, 16). In addition to the North Atlantic stations noted, it also was caught in the Gulf of Mexico (P-6803, Sta. 8) and the Florida Straits (P-6904, Sta. 1).

E. mutica was intermediate in abundance and frequency of capture (Table 60). Like _E. hemigibba_, samples containing this species either came from TSW and upper SUW at depths of 0-95 m or from NACW between 175 and 500 m (Fig. 28B, Table 65). Specimens from the upper 95 m, comprising 61% of the total catch of _E. mutica_, were all caught during the dark hours except once, at dusk in an area affected by upwelling near Panama, where the bottom depth was only 219 m (P-6606, Sta. 14). Conversely, the 39% found between 175 and 500 m were all collected during daylight with the exception of those from 175 m at P-6803, Sta. 8, in the northeastern Gulf of Mexico. This is another shallow location, bottom depth 237 m, and the only one at which _E. mutica_ was caught at more than one depth. It was much more numerous in two shallower tows than it was at 175 m (Table 65). From the data available, it appears that this species usually occurs above 100 m at night and between 250 and 500 m during the daytime in the open Caribbean and tropical western Atlantic.

Euphausia pseudogibba, a new record for the Caribbean, is poorly known in the Atlantic. It has been reported from the northwest between 35° and 40°N (Mauchline & Fisher, 1969), from the Gulf of Mexico (James, 1970) and from

waters off the Orinoco Delta (Legaré, 1961). Although Lewis (1954) and others did not find it in the Florida Straits, Jeanne Stepien (personal communication) has identified males and females in samples collected below 600 m at a station off Miami, Florida.

Only 46 specimens were collected (total counts, Table 66), all within the Caribbean Sea. A few were caught in SUW at night (P-6701, Sta. 18; P-6805, Sta. 10), but the majority were living in NACW between 250 and 550 m and were netted during daytime (Fig. 29A).

Euphausia tenera is a species of tropical and subtropical Atlantic, Pacific and Indian Oceans, occurring from 40°N to about 20°S in the western Atlantic (Mauchline & Fisher, 1969). Legaré (1961) first reported it from the Caribbean Sea. A broad vertical range is recorded in our data (0-1000 m, Table 60); according to Moore (1949), it usually is found below 300 m. However, Lewis (1954), Lewis & Fish (1969), and Owre & Foyo (1972) have reported it from surface waters at night. Lewis & Fish (1969) also described it as the most common species of euphausid in the Barbados area, as it was in the present collections. In addition to Caribbean stations, E. tenera was found in the North Atlantic (P-6911, Sta. 13, 14, 15), the Old Bahama Channel (P-6904, Sta. 21) and the Florida Straits (P-6904, Sta. 1).

Roger (1974) described E. tenera as a migrating species, abundant only below 300 m in the day and concentrated almost entirely above the thermocline at night. Our data show a similar distributional picture (Fig. 29B, Table 67). It occurred primarily in TSW where 80% of the 6789 specimens were caught in the upper 100 m at night. A few (16%) were collected below 224 m during daytime sampling in SUW, NACW and SAIW.

Nematobrachion boopis, a mesopelagic species occurring off the Atlantic seaboard, in the Florida Straits and the Gulf of Mexico (James, 1970; Mauchline

& Fisher, 1969), apparently is a new record for the Caribbean. It was not collected in the adjacent areas. Roger (1974) characterized it as a non-migrating or feebly-migrating form found between 350 and 800 m in the tropical Pacific. Its deep-living habit it illustrated by the data from the Caribbean, where it was collected over a relatively narrow range of temperature and salinity in NACW and SAIW, at depths of 400-1000 m (Fig. 34A, Table 68). Baker's (1970) distributional records are similar. N. boopis and N. flexipes are among the most rare and infrequently caught euphausiid species in our collections.

Nematobrachion flexipes also is a new Caribbean record. It is known from 40°N to the Florida Straits in the western North Atlantic, from the waters off northeastern South America and from the Gulf of Mexico (James, 1970; Mauchline & Fisher, 1969). It was collected only at Caribbean stations. Mauchline and Fisher stated that it lives between 280 and 700 m in the daytime and above 280 m at night, which is in broad agreement with Roger's (1974) observation that it occurs between 350 and 600 m in the day and congregates around the thermocline with a range of 100-300 m at night. In the Caribbean, N. flexipes was most frequently caught in NACW at depths of 259-2454 m during daylight hours, but the greatest numbers appeared in a pre-dawn (local apparent time) tow well above the thermocline at 45 m in TSW (Fig. 30A, Table 69).

Nematoscelis megalops has been reported from the northwestern North Atlantic to the Florida Straits but not from the Gulf of Mexico (James, 1970; Mauchline and Fisher, 1969). Owre and Foyo (1972) collected it in the Yucatan Channel. The present records appear to be the first from the Caribbean. It was also found at one North Atlantic station (P-6904, Sta. 17). According to Mauchline and Fisher, it probably occurs below 300 m during the day, migrating towards the surface at night. Baker (1970) recorded a range of 410-625 m in the daytime and 50-910 at night. His data suggested a very patchy distribution. Our records,

from 200-593 m in SUW and NACW, are too few to show vertical movement, although all catches at less than 258 m were made at night (Fig. 30B, Table 70).

Because of the difficulties in separating adolescents and adult females of N. microps and N. atlantica, summarized by Baker (1970), the two species are considered together as Baker has done. N. microps is known from the western North Atlantic, the Florida Straits and the Gulf of Mexico (James, 1970; Legaré, 1961; Mauchline and Fisher, 1969), and in the area concerned, N. atlantica was recorded by James (1970) and Lewis (1954). In addition to the Caribbean records, N. microps/atlantica was found at stations in the North Atlantic (G-6722, Sta. 9, 10, 12) and in the Florida Straits (P-6904, Sta. 1). Roger (1974) described N. microps as a common, broadly distributed, migrating species in the tropical Pacific, living between 250 and 500 m in the daytime and concentrated around the thermocline at night, with a range of 100-300 m. In contrast, N. atlantica was rare, "antiequatorial" and none was caught north of 13°05'S. Our records agree in general with Roger's findings, but it is obvious that the populations of Nematoscelis were not adequately sampled with horizontally towed 3/4 m nets. A few specimens were collected in SUW and most in NACW over a range of 132-781 m (Fig. 31A, Table 71). All catches in the upper 250 m occurred at night.

Nematoscelis tenella was described by Mauchline and Fisher (1969) as a mesopelagic species, widely distributed in the Atlantic, Pacific and Indian Oceans. James (1970) reported it for the first time from the Gulf of Mexico, and Tattersall (1926) and Lewis (1954) collected it in the Florida Straits. Present records include two from the North Atlantic (P-6904, Sta. 15, 18) and one from the Straits (P-6904, Sta. 22). Roger (1974) found it, like N. microps, common in the tropical Pacific and characterized it as a non- or feebly-migrating species living in the range 150-500 m at 16-7°C. In the Caribbean data, it resembles N. megalops in its vertical distribution which is somewhat deeper than that found

by Roger (Tables 60 and 72). It occurred in NACW (Fig. 31B), within the temperature range cited by Roger.

Stylocheiron abbreviatum is broadly distributed in the major oceans, mainly between 40°N and 40°S. James (1970) reported it from the Gulf of Mexico, Lewis (1954) and Tattersall (1926) from the Florida Straits and Legaré (1961) from the area off the delta of the Orinoco River, but it has not been recorded from the Caribbean. It was collected in small numbers at two Caribbean stations and at P-6904, Sta. 21 in the Old Bahama Channel (Table 59). According to Mauchline and Fisher (1969), it lives between 75 and 300 m, and to Baker (1970), 50-500 m. Roger (1974) described it as a non- or feebly-migratory species of the range 50-300 m and noted for swarming. Apparently, it avoids surface waters, or Lewis and Fish (1969) probably would have caught it during their two-year semi-monthly program of sampling at night. S. abbreviatum occurred in SUW over a narrow depth range (220-250 m, 18.5-19.3°C, 36.59-36.63 o/oo) and was also collected once in NACW (297 m, 16.5°C, 36.28 o/oo). All were night tows.

The geographical distribution of Stylocheiron affine is similar to that of S. abbreviatum (James, 1970; Legaré, 1961; Mauchline and Fisher, 1969), but it has not been reported from the Florida Straits. It, too, is a new record for the Caribbean. It was caught once in the North Atlantic, at P-6904, Sta. 18. Most specimens were collected in TSW and SUW, and it also occurred in NACW (Fig. 32A, Table 73). There is no clear evidence of vertical migration in our data, although its range was 0-265 m and 73% of the specimens were caught in the upper 110 m at night. Roger (1974) classified it as a non- or feebly-migrating species, living between 50 and 150 m at 25-16°C. A slightly greater temperature range was recorded in the Caribbean. Baker (1970) found a greater depth range (0-780 m) off the Canary Islands, but the majority were taken in the upper 130 m.

Stylocheiron carinatum, like the two preceding species, is broadly distributed in the Atlantic, and it also is known from the Gulf of Mexico (James, 1970), the Florida Straits (Lewis, 1954; Tattersall, 1926) and the Yucatan Channel (Owre and Foyo, 1972). The present records, the first from the Caribbean, include one from the Gulf of Mexico (P-6803, Sta. 4). It is among the more numerous but infrequently collected euphausiid species in the collections. Mauchline and Fisher (1969) stated that it probably lives between 50 and 300 m in the daytime, moving toward the surface at night, but Roger (1974), who acknowledged that the species was very poorly sampled by the IKMT, described it as a non- or feebly-migrating species of the upper 150 m. In the Caribbean, the vertical range and frequency of capture recorded for S. carinatum was similar to that of S. affine. Only once, however, were the two species found in the same sample (P-6701, Sta. 10, 110 m). S. carinatum was collected exclusively in TSW and SUW (Fig. 34B, Table 74).

Stylocheiron elongatum, unlike the other members of the genus discussed earlier, is mesopelagic. It is found in the Atlantic, Pacific and Indian Oceans between 40°N and 40°S, usually collected between 100 and 500 m, according to Mauchline and Fisher (1969). Baker (1970) collected adults between 150 and 700 m. Roger (1974) described it as a non- or feebly-migrating species in the equatorial and south tropical Pacific, living between 250 and 600 m. It occurs in the Gulf of Mexico (James, 1970) and the Florida Straits (Lewis, 1954; Tattersall, 1926), but it has yet to be recorded from the Caribbean. Five females were collected at 372 m in the Straits (Table 59) in NACW, 13.9°C, 35.79 o/oo. Although he realized that it was poorly retained by the IKMT, Roger still considered it a rarity in the tropical Pacific, and so it may be in the Caribbean.

Stylocheiron longicorne, described by Mauchline and Fisher (1969) as a mesopelagic species of the Atlantic, Pacific and Indian Oceans, has been recorded

between 65°N and 40°S in the Atlantic where it is said to live between 300 and 500 m. In the tropical Pacific, however, Roger (1974) found it an epipelagic form of the 50-300 m range. Tattersall (1926) and Lewis (1954) reported it from the Florida Straits, James (1970) from the Gulf of Mexico, and Owre and Foyo (1972) from 250 m in the Yucatan Channel and 237 m in the eastern Caribbean. It was one of the most numerous and frequently caught euphausiid species (Table 60). In addition to Caribbean samples, it appeared in collections from adjacent areas (North Atlantic, G-6722, Sta. 9, 12; P-6904, Sta. 17; P-6911, Sta. 16; Old Bahama Channel, P-6904, Sta. 20, 21; Florida Straits, P-6904, Sta. 22; Gulf of Mexico, P-6803, Sta. 8).

Although it was collected over a broad depth range (Table 75), the vertical distribution of S. longicorne in the Caribbean generally agrees with the observations of Roger (1974), since 94% of the 2416 specimens were caught in the upper 300 m. Roger also found it a non- or feebly-migrating species. Our data suggest that at least some of the populations undergo a limited migration because all specimens found in the upper 100 m, 36% of the total, and even in the upper 200 m, 41%, were collected at night. The relatively large numbers found in night samples in TSW and the upper SUW appear in Fig. 32B, which also shows the clustering of most specimens in lower SUW and upper NACW. On the other hand, Baker's (1970) data suggested a short-range reversed diurnal migration. In summary, Baker wrote, "Thus the evidence regarding the existence of a diurnal migration...is conflicting, but it is consistent in that any migration that occurs,...normal or reversed, is only of short range."

Stylocheiron suhmii is another widely distributed species, found in the Atlantic between about 40°N and 40°S and probably living at about 300 m, according to Mauchline and Fisher (1969). It has been reported from the Florida Straits (Lewis, 1954; Tattersall, 1926), the Gulf of Mexico (James, 1970), and north-

eastern South America (Legaré, 1961; Owre and Foyo, 1972) but not from the Caribbean Sea. It was collected at six Caribbean stations, once in the Florida Straits (P-6904, Sta. 1) and once in the North Atlantic (P-6904, Sta. 16). It was most numerous at the latter two stations (Table 76).

Roger (1974) classified it as an essentially non-migratory species of the upper 300 m. Off the Canary Islands, Baker (1970) found the daytime range to be 0-410 m, with 89% occurring between 40 m and the surface, and the night range 0-500 m. There was no detectable migration. Our few records indicate that it is epipelagic, living over a very narrow range of depth in the areas sampled and shallower than most of the levels given in the literature. In their night surface tows west of Barbados, Lewis and Fish (1969) reported that it occurred infrequently and in small numbers. Owre and Foyo (1972) found it in a night surface sample from oceanic water not far from the mouth of the Amazon River. S. suhmii seems to avoid tropical surface waters in daylight hours, or it is an effective avoider of nets in the upper layers during the day (Brinton, 1967). Its distribution in TSW and, primarily, SUW is shown in Fig. 34C.

Thysanopoda aequalis has been reported from the Florida Straits (Lewis, 1954; Tattersall, 1926) and, by Moore (1952) from the Gulf of Mexico, where James (1970) instead found Thysanopoda subaequalis Boden, 1954. James suggested that Moore may have confused the two species. Owre and Foyo (1972) reported T. aequalis from 120, 250 and 500 m in the Yucatan Channel and from 500 m off the northeastern coast of South America. However, the present records appear to be the first from the Caribbean, and they include collections from the North Atlantic (P-6904, Sta. 15), the Old Bahama Channel (P-6904, Sta. 21) and the Florida Straits (P-6904, Sta. 21 and 22). This was not a common species, nor was it frequently caught (Table 60).

Concerning vertical distribution, Mauchline and Fisher (1969) stated that T. aequalis is associated with temperatures of 11-16°C at 200 m and that adults are present below 140 m during the day. In the tropical Pacific, however, Roger (1974) found it abundant only below 300 m in the daytime (300-600 m, 12-7°C) but migrating and concentrating almost entirely above the thermocline at night (0-160 m, 25-16°C). Our data (Fig. 33A, Table 77) show that 46% of the total number of 461 specimens was caught between the surface and 100 m in TSW and upper SUW at night while 54% were living below 100 m according to daytime samples. Most of the latter came from NACW, in the temperature range given by Roger.

Thysanopoda monacantha is a mesopelagic species occurring primarily in the tropical regions of the Atlantic, Pacific and Indian Oceans (Mauchline and Fisher, 1969). Roger (1974) described it as a migrating species in the tropical Pacific, abundant during the day between 350 and 600 m, 11-7°C, and, at night, distributed above, in, and below the thermocline (50-300 m, 25-12°C). It has been reported from the Florida Straits (Lewis, 1954; Tattersall, 1926) and the Gulf of Mexico (Chace, 1956; James, 1970). Hansen (1915) identified one specimen from 15°28'39"N, 80°36'W in the western Caribbean. The six specimens in the present collection, also from the western Caribbean (Table 59), were caught at 240 m (15.1°C, 35.99 o/oo) at night and at 480 m (9.4°C, 35.15 o/oo) during morning. T. monacantha is best sampled by a large, high-speed net, as the reports of James and Roger show. James found small numbers in the meter net hauls but collected as many as 55 in a 10' midwater trawl.

Thysanopoda obtusifrons, a deep-living species widespread in tropical and and subtropical regions, has seldom been reported from the western North Atlantic and never from the Caribbean Sea (Mauchline and Fisher, 1969). James' (1970) 68 specimens, all but two caught in midwater trawls, were the first records of the species in the Gulf of Mexico. It was found in five Caribbean samples and one

from the Old Bahama Channel (P-6904, Sta. 19; Table 78). In the tropical Pacific, _T. obtusifrons_ lives below 400 m during the day and migrates into the upper 200 m, where it is particularly abundant during the beginning of the night hours, from approximately 1900 to 0100 h (Roger, 1974). Baker (1970) found similar distributions, and our few data are in almost complete agreement. During the day, it occurred in NACW at 500 m and deeper, while the night tows, which began at 2138, 2237 and 0255 h local apparent time, caught it at 55-237 m in SUW (Fig. 33B).

Thysanopoda pectinata, a mesopelagic species, is poorly known in the western North Atlantic (Mauchline and Fisher, 1969) and has not previously been reported from the Caribbean. However, it has been reported from the Gulf of Mexico by Hansen (1915), Chace (1956) and James (1970), who caught 28 specimens in mid-water trawls and none in meter nets. Roger (1974) grouped it with _T. obtusifrons_ and _T. tricuspidata_, migrating species which live below 400 m during the day and in the upper 200 m in the earlier part of the night. Roger's ranges for _T. pectinata_ alone were 350-600 m, 11-7°C, in daytime, and 200-500 m, 13-7°C, at night. One specimen was found in the Caribbean collections (Table 59).

Thysanopoda tricuspidata occurs between 40°N and 40°S but is most numerous between 20°N and 15°S in the Atlantic, and it lives below 500 m during the day, according to Mauchline and Fisher (1969). Roger (1974), who found it very abundant, often in large swarms, grouped it with species caught below 400 m in the daytime and above 200 m at night. Rare in our collections, it was found only in NACW at depths of 372-2660 m during the day and at 2490 m in one night tow (Table 79). All of these stations were located in the Caribbean except for one in the Florida Straits (P-6904, Sta. 22), where Tattersall (1926) and (1954) previously collected it. In the Gulf of Mexico, James (1970) caught from two to 16 specimens in seven meter net hauls and as many as 23 in 17 midwater trawls.

The horizontal distribution of all euphausiid species at selected stations in the Caribbean is summarized in Fig. 35 and Table 61. Figure 35 also illustrates the inadequacy of the sampling technique and, probably, patchiness, in that the smallest numbers were often collected adjacent to stations where relatively large numbers were found. On the other hand, differences in the averages of abundance in major areas, given in Table 61 , show that the data indicate broad regions of higher and lesser productivity. The widest range in numbers and the greatest average figure were found in areas affected by upwelling in the south central Caribbean off the coasts of Colombia, Panama, Costa Rica and Nicaragua, particularly in the western portion. Slightly more than half of this abundance occurred in both the eastern and the central Caribbean areas. The lowest figure was found in the western Caribbean, exceeded slightly by the numbers collected in passages. The greater average found in the Yucatan Channel probably resulted from the concentration of organisms there as the waters flow rapidly north and northeastward into the Gulf of Mexico and the Florida Straits.

Table 61

Data on horizontal distribution of euphausiids, summarized from Table 23.

Location	No. of Stations	Range in No. Euphausiids Collected	Avg. of Total No. Collected Per Station
Yucatan Channel	4	40-790	367
Western Caribbean	8	0-465	232
Central Caribbean	6	170-1160	496
Eastern Caribbean	14	0-1572	533
Areas of upwelling	12	0-3350	907
Passages	4	6-450	267

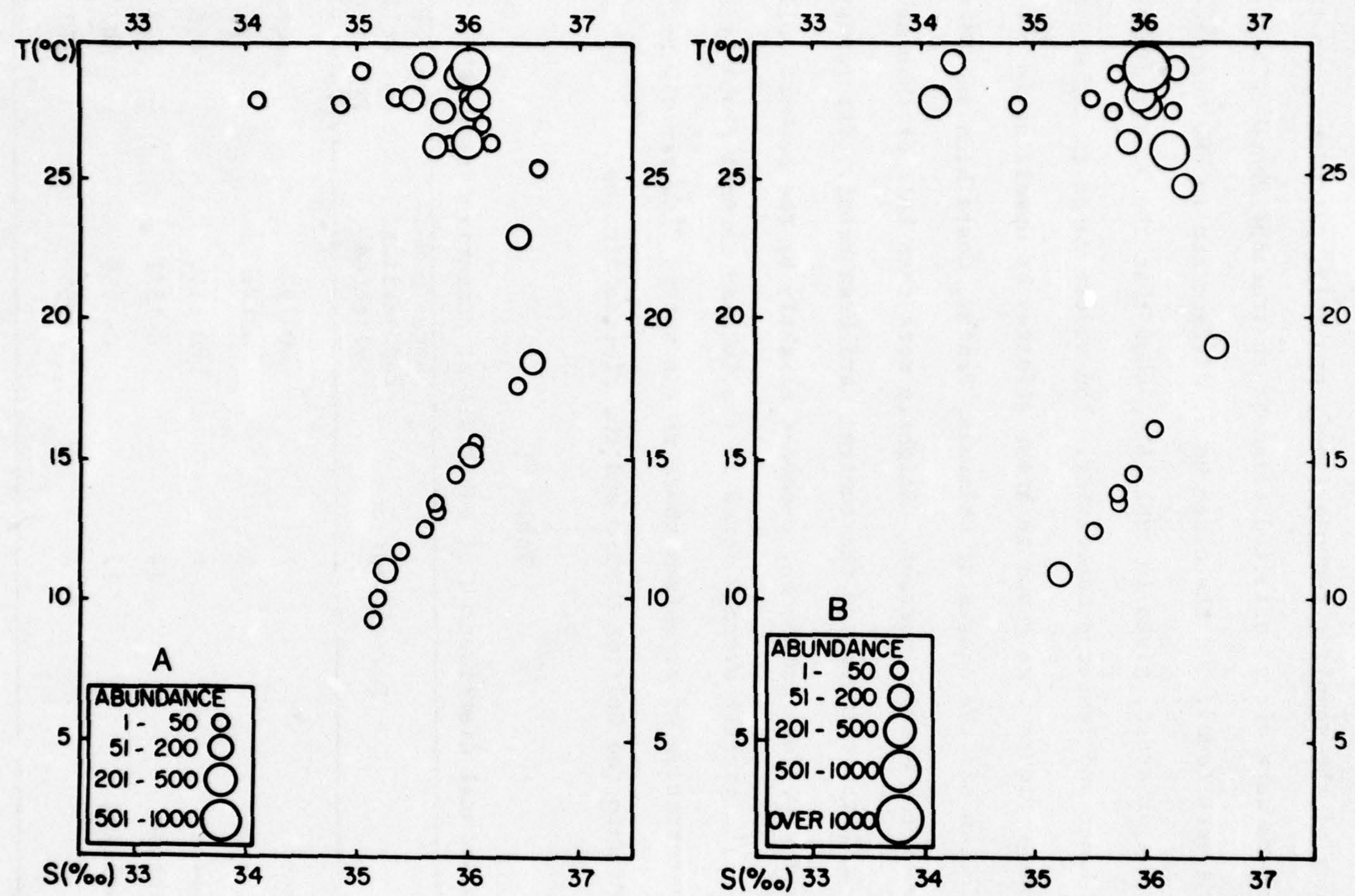

Figure 27. T-S-P diagrams, (A) Euphausia americana and (B) E. brevis

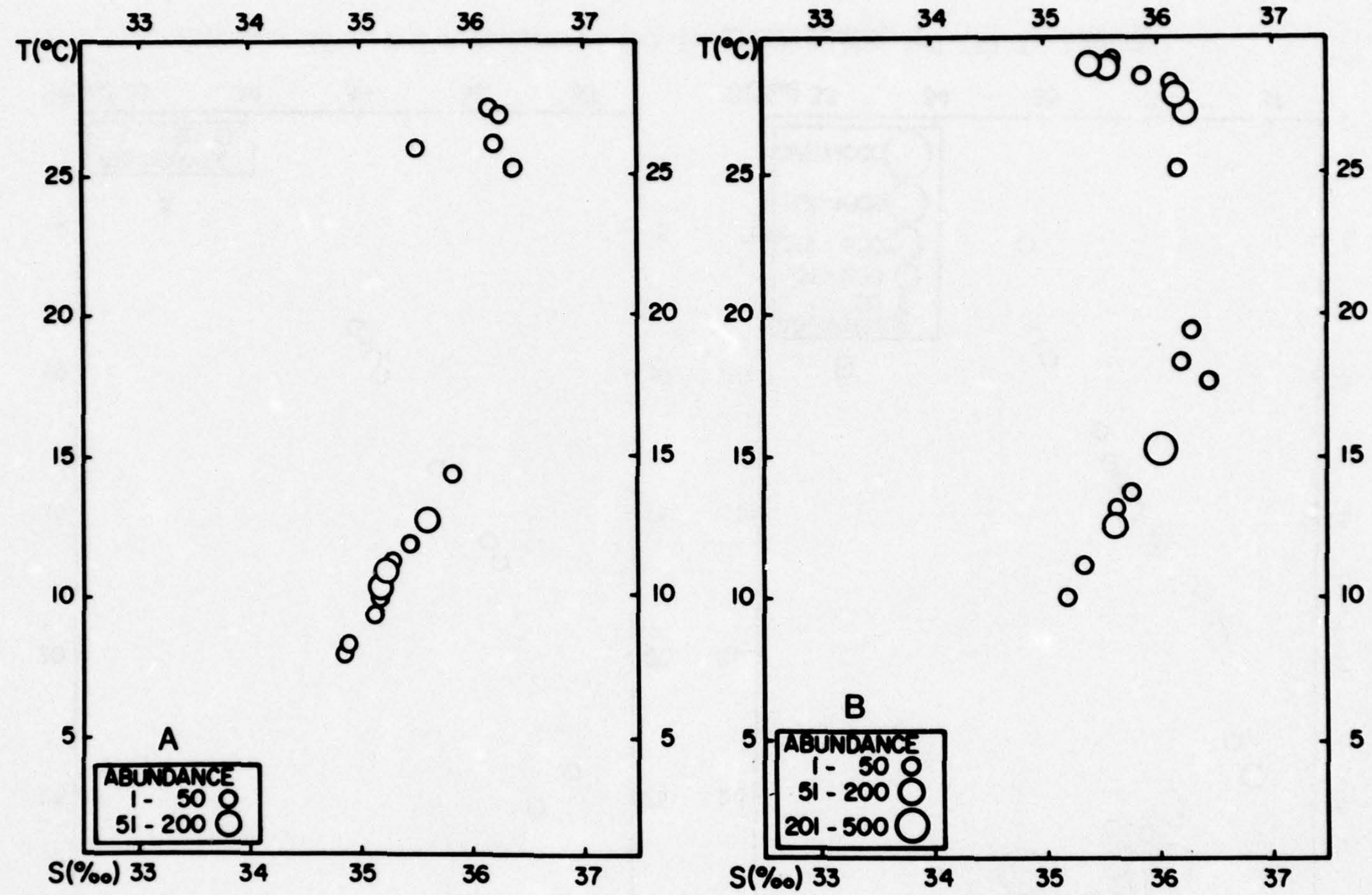

Figure 28. T-S-P diagrams, (A) _E. hemigibba_ and (B) _E. mutica_

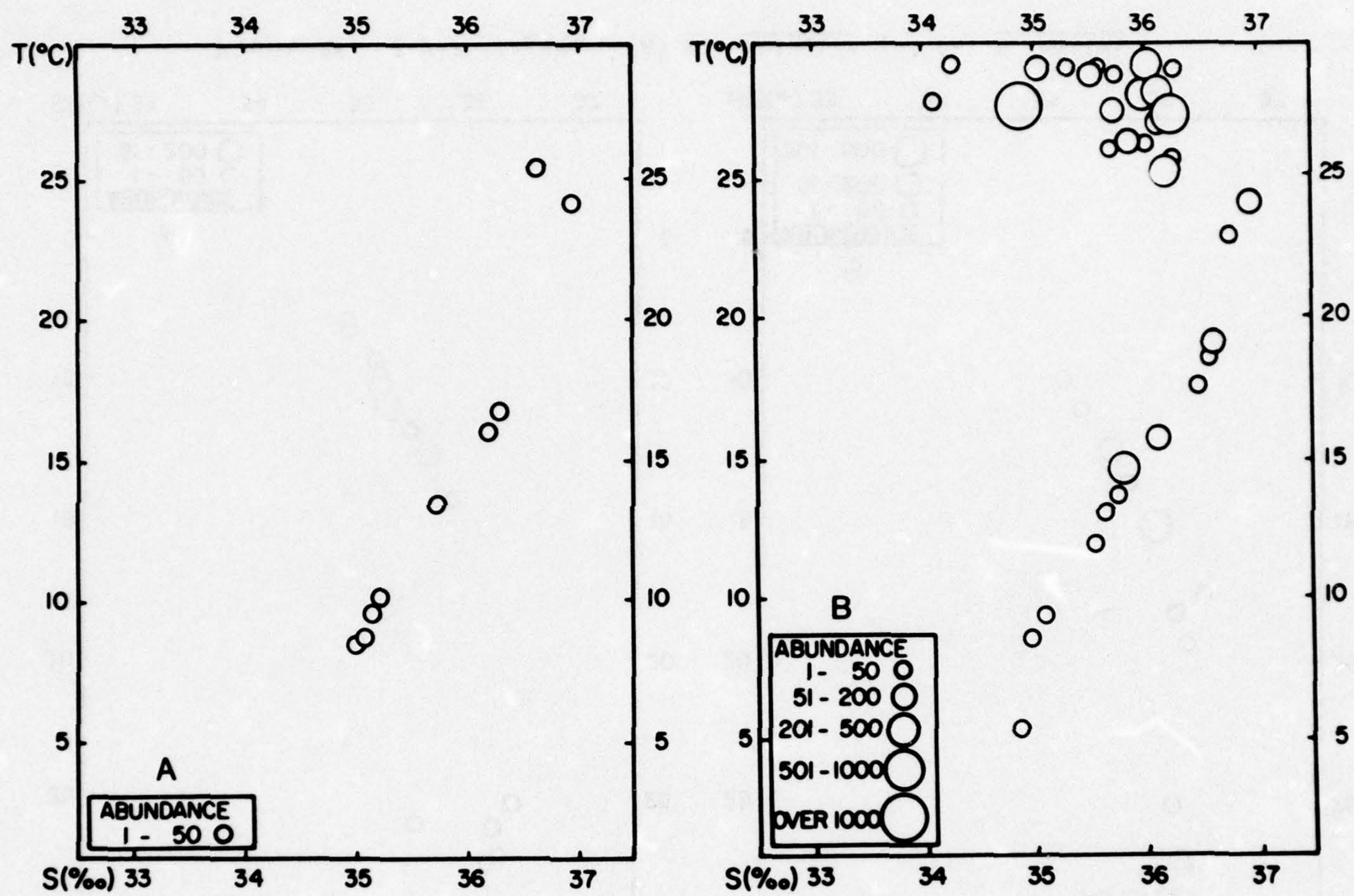

Figure 29. T-S-P diagrams, (A) E. pseudogibba and (B) E. tenera

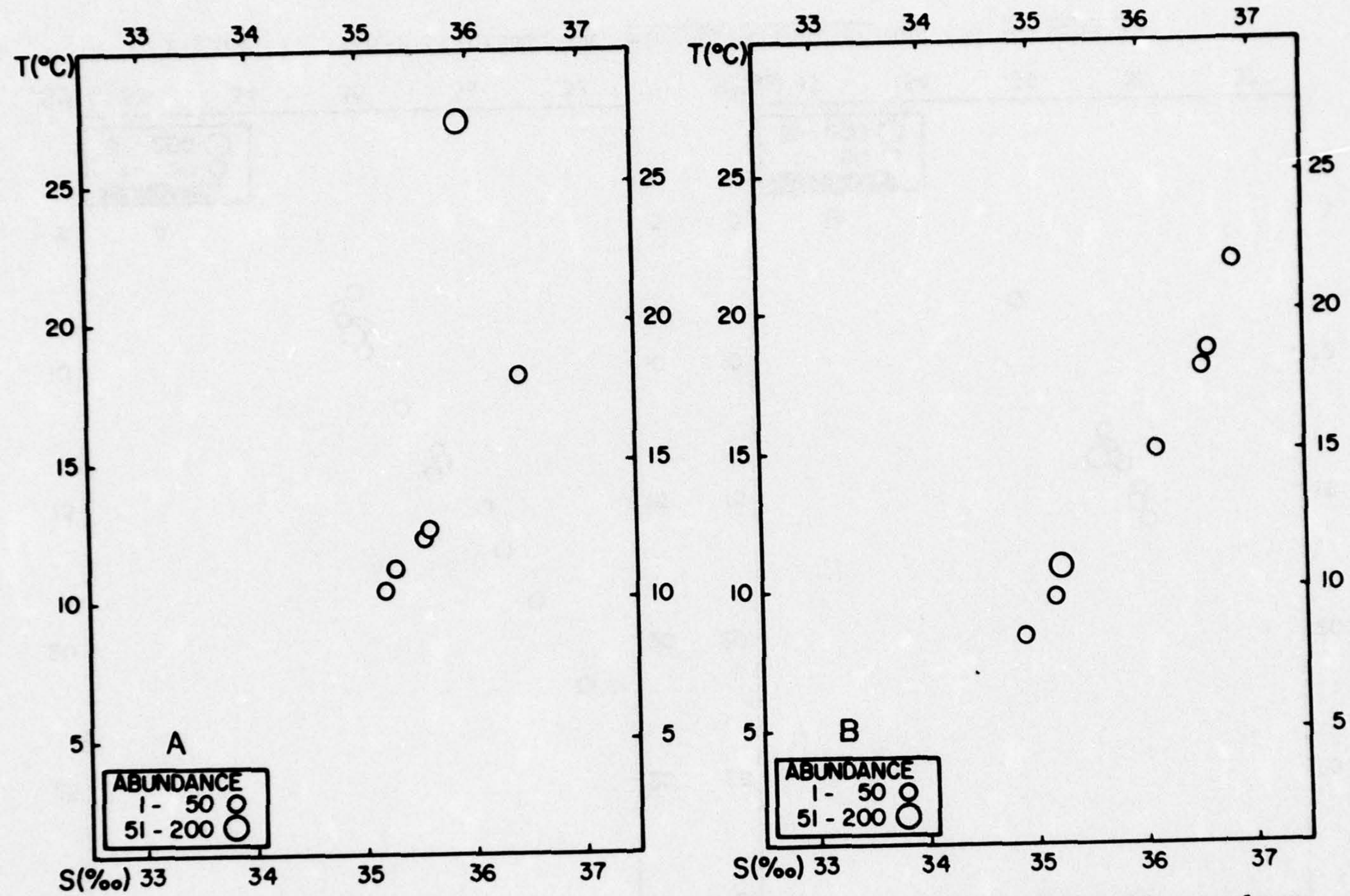

Figure 30. T-S-P diagrams, (A) Nematobrachion flexipes and (B) Nematoscelis megalops

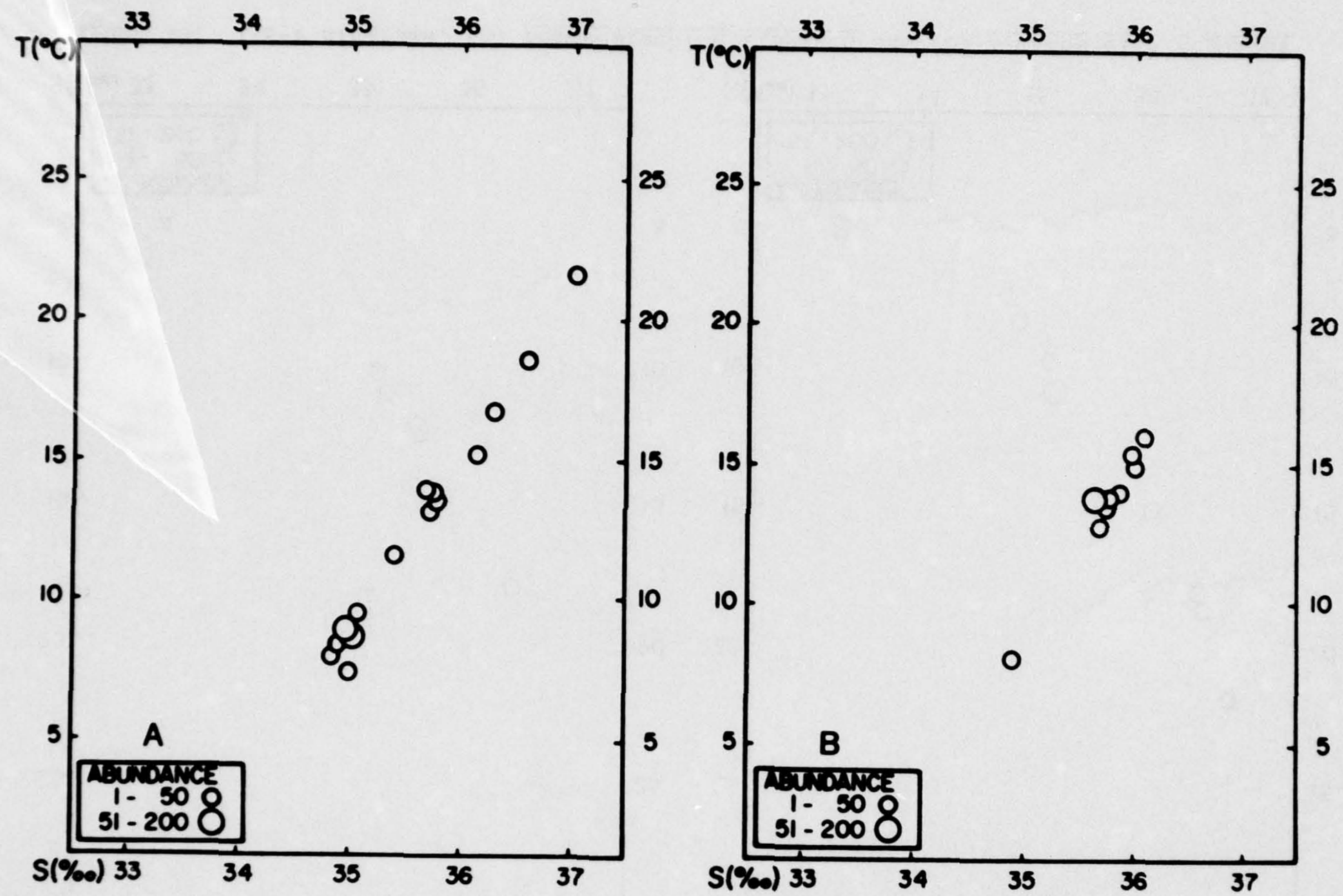

Figure 31. T-S-P diagrams, (A) microps/atlantica and (B) N. tenella

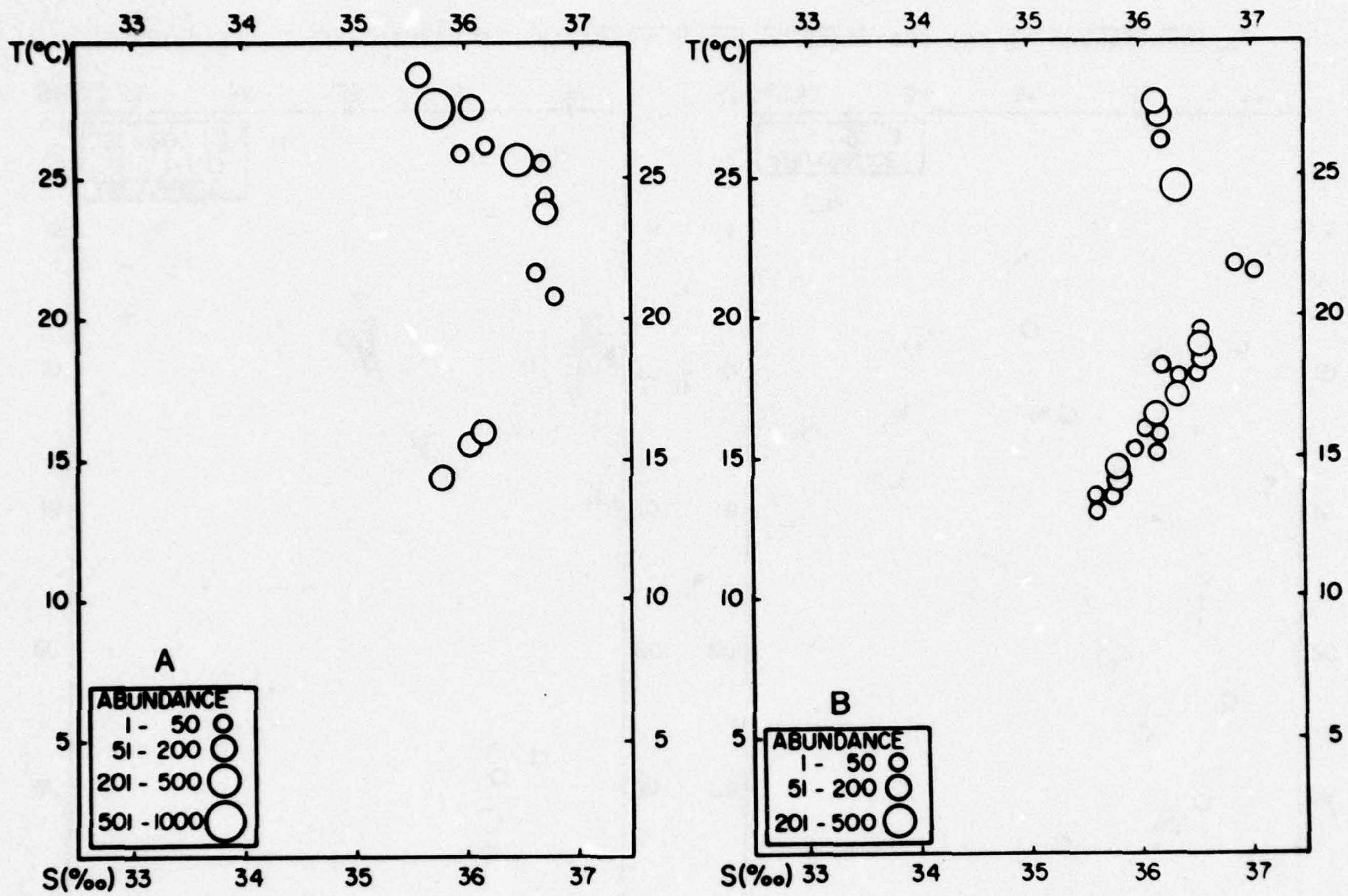

Figure 32. T-S-P diagrams, (A) _Stylocheiron_ _affine_ and (B) _S_. _longicorne_

Figure 33. T-S-P diagrams, (A) <u>Thysanopoda aequalis</u> and (B) <u>T. obtusifrons</u>

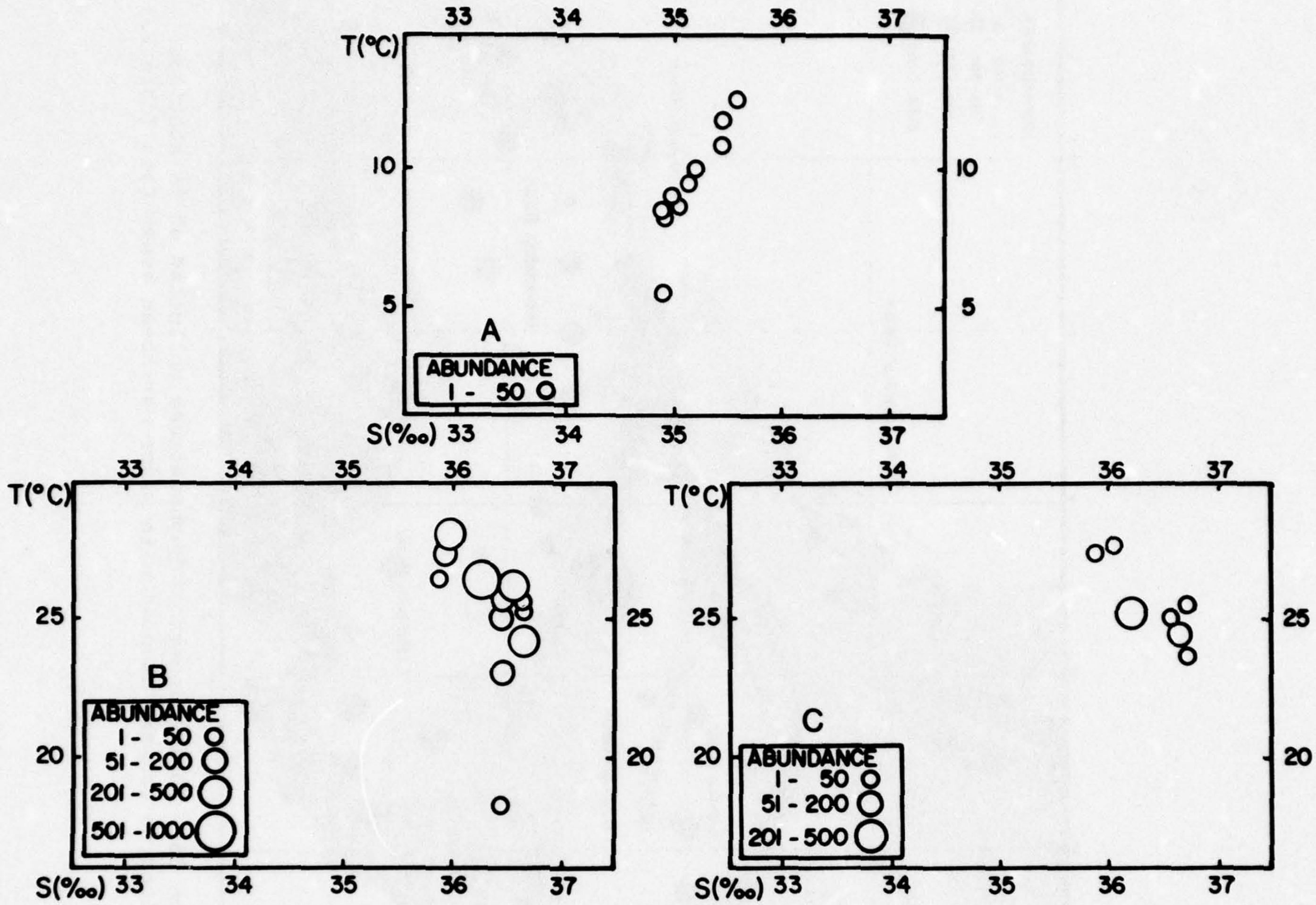

Figure 34. T-S-P diagrams, (A) <u>Nematobrachion boopis</u>, (B) <u>Stylocheiron carinatum</u> and (C) <u>S. suhmii</u>

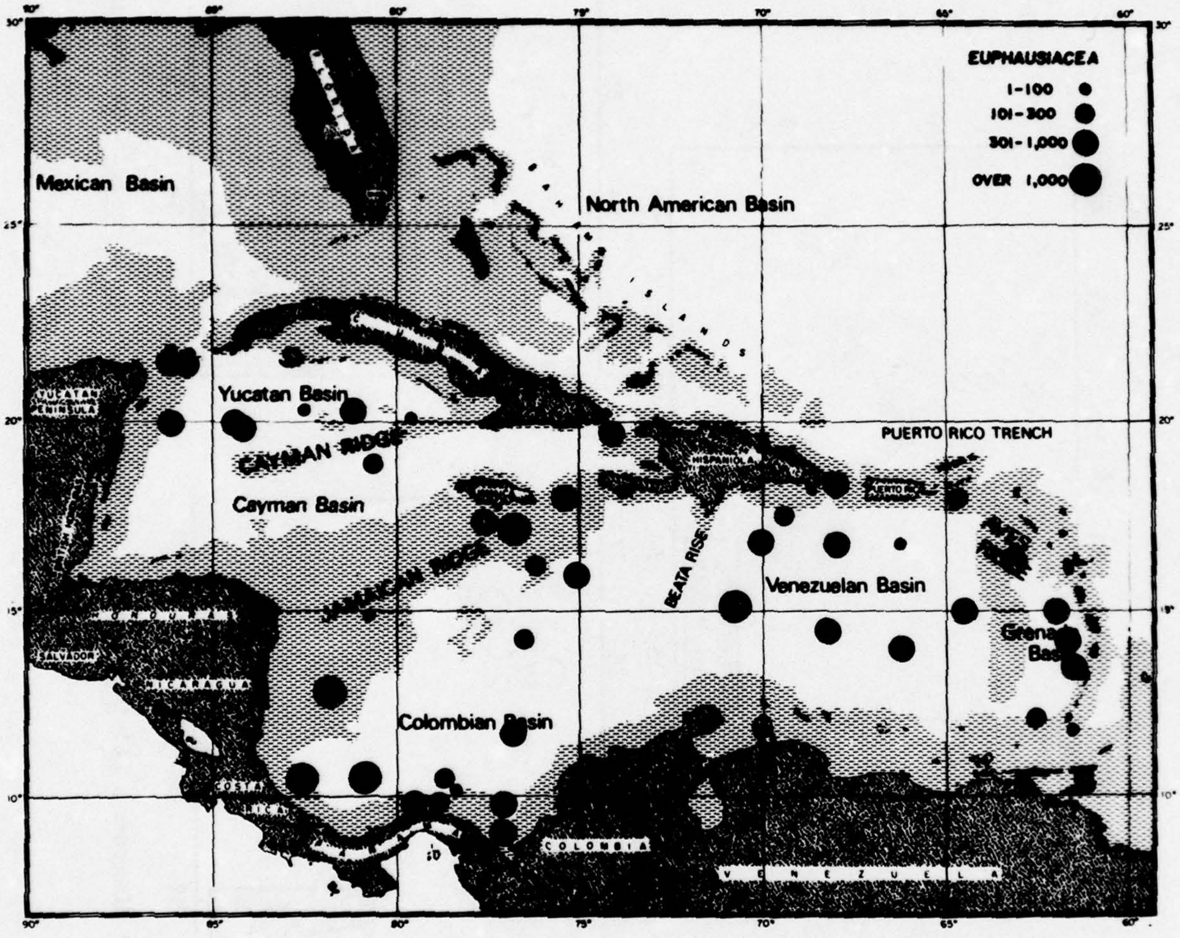

Figure 35. Total numbers of Euphausiacea collected at 48 stations selected to compare abundance in major Caribbean areas (see Table 23)

TABLE 62

Vertical distribution of *Euphausia americana*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6701	2	350	2 ♀
	5	0	50 ♀
	11	500	8 ♂♀
	13	450	30 ♀
	16	398	3 ♀
	20	250	60 ♂ ♀
G-6722	4	0	50 ♀
	9	40	100 ♀
P-6803	4	30	100 ♀
	11	2500	12 ♂ imm.
	16	0	60 ♂
	18	480	20 ♀
	22	0	50 ♂♀
	25	0	20 ♂
P-6805	5	0	50 ♀
	10	0	50 ♀
		55	50 ♀
	11	0	100 ♀
P-6811	7	375	80 ♂ ♀
	9	0	50 ♀
	10	0	50 ♀
		25	100 ♀
	11	0	600 ♂ ♀
	12	775	4 ♀
	18	0	200 ♂ ♀
	19	0	150 ♂ ♀
	20	500	20 ♀
P-6904	1	0	250 ♂ ♀
	4	470	50 ♂ ♀
	9	236	60 ♀
	10	455	10 ♂
	14	458	10 ♂

TABLE 62 (continued)

Vertical distribution of *Euphausia americana*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6911	2	1272	2 ♀
	10	0	50 ♂
	11	234	30 ♂
	12	344	40 ♂ ♀
		410	20 ♂
	14	0	60 ♂ ♀
		34	200 ♂ ♀
	16	0	30 ♂
	17	514	10 ♀

TABLE 63

Vertical distribution of *Euphausia brevis*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	4	0	100 ♀
P-6701	2	500	100 ♂ ♀
	4	0	10 ♂ ♀
	5	0	100 ♂ ♀
	8	250	20 ♂
	16	398	3 ♀
G-6722	4	0	300 ♂ ♀
	10	405	9 ♂ ♀
P-6803	20	75	60 ♂ ♀
	22	0	50 ♂ ♀
P-6805	9	0	500 ♂ ♀
	10	0	200 ♀
	11	0	50 ♂
P-6811	1	0	50 ♀
		38	150 ♂ ♀
	4	270	20 ♂
	7	375	60 ♂ ♀
	9	0	50 ♂
	11	0	1300 ♂ ♀
	17	485	20 ♀
	19	0	150 ♀
		75	1 ♂
P-6904	6	31	40 ♂
	13	0	300 ♂ ♀
	20	0	70 ♂ ♀
		10	700 ♂ ♀
	21	0	10 ♀
		50	200 ♂ ♀
	22	372	10 ♀
P-6911	1	65	50 ♂
	5	1878	2 ♀

TABLE 63 (continued)

Vertical distribution of Euphausia brevis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
	13	0	100 ♀
	15	224	60 ♂ ♀
	16	0	90 ♂ ♀
	17	514	20 ♂ ♀

TABLE 64

Vertical distribution of *Euphausia hemigibba*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	8	100	20
	12	300	25
P-6701	2	350	6
	5	90	50
	11	500	14
P-6803	15	400	10
	16	100	40
	18	480	10
	20	75	20
P-6811	3	500	20
	7	375	140
	11	590	25
	15	470	5
P-6904	11	524	10
	22	450	60
P-6911	2	53	50
	3	494	20
	8	510	60

TABLE 65

Vertical distribution of <u>Euphausia</u> <u>mutica</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	13	300	25♀
	14	10	150♂♀
P-6701	11	500	10♂♀
	13	450	30♀
	20	250	210♂♀
G-6722	17	250	20♀
P-6803	8	40	50♀
		95	50♂
		175	30♀
P-6811	6	25	50♀
P-6904	1	38	50♀
	10	455	60♂ ♀ imm.
P-6911	4	81	100♀
	9	60	150♀
	11	234	30♀
	12	344	80♂ ♀
	13	65	100♂ ♀
	14	0	30♀
	16	0	30♀

TABLE 66

Vertical distribution of Euphausia pseudogibba

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6701	1	530	1 ♂
	8	505	2 ♂♀
	11	500	6 ♂♀
	12	500	3 ♂♀
	18	100	3 ♂♀
	24	500	5 ♂♀
P-6805	9	250	2 ♂
	10	55	11 ♂♀
P-6904	3	265	1 ♀
		550	2 ♂♀
	4	470	10 ♂♀ imm.

TABLE 67

Vertical distribution of *Euphausia tenera*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	4	0	200 ♀
	12	100	50 ♂
	13	300	25 ♂
		500	20 ♀
P-6701	2	500	200 ♂ ♀
	4	0	15 ♂ ♀
	5	0	150 ♂ ♀
	8	250	20 ♂
	10	1000	5 ♂
	18	100	100 ♂
G-6722	4	0	50 ♀
	17	250	20 ♂ ♀
P-6803	16	0	20 ♀
	25	0	100 ♂ ♀
P-6805	2	0	300 ♂ ♀
	3	250	50 ♂
		500	30 ♀
	9	0	250 ♂ ♀
P-6811	1	0	50 ♀
		38	50 ♀
	5	250	350 ♂ ♀
	6	0	100 ♀
	9	0	2350 ♂ ♀
	11	0	400 ♂ ♀
		45	50 ♀
	19	0	100 ♂ ♀
		75	1 ♂
P-6904	1	0	50 ♂
		38	250 ♂ ♀
	2	500	10 ♂
	6	31	120 ♀

TABLE 67 (continued)

Vertical distribution of Euphausia tenera

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
	7	0	50 ♂
		25	50 ♀
	9	236	30 ♀
	21	490	3 ♀
P-6911	7	253	120 ♀
	10	0	100 ♀
	11	58	50 ♀
	12	344	100 ♀
	13	0	50 ♀
		65	600 ♂ ♀
	14	0	30 ♂
	15	224	120 ♂ ♀

TABLE 68

Vertical distribution of Nematobrachion boopis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6701	10	1000	5 ♀
	11	500	6 ♂♀
	12	500	10 ♀
P-6803	15	400	10 ♀
	16	420	4 ♀
	22	470	20 ♀
	26	480	20 ♀
P-6811	8	480	10 ♂
P-6904	3	550	30 ♂
P-6911	3	494	30 ♂♀
	7	539	20 ♀

TABLE 69

Vertical distribution of _Nematobrachion flexipes_

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	4	285	25 ♀
P-6701	16	398	3 ♂
P-6904	10	455	10 ♀
	11	45	100 ♀
	12	259	10 ♀
		515	10 ♀
P-6911	8	510	20 ♀
	9	2454	1 ♂

TABLE 70

Vertical distribution of *Nematoscelis megalops*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	4	593	10 ♀
P-6803	22	200	30 ♀
		470	20 ♀
P-6811	7	375	80 ♂ ♀
		500	20 ♂ ♀
P-6904	13	258	10 ♀
	17	251	20 ♀
P-6911	1	250	50 ♀

TABLE 71

Vertical distribution of <u>Nematoscelis microps</u>/<u>atlantica</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6701	5	250	10 ♂
	24	500	20 ♀
G-6722	9	155	10 ♂
		320	5 ♀
	10	405	3 ♀
	12	181	40 ♀
	15	132	3 ♀
P-6805	9	250	30 ♀
P-6811	6	485	60 ♂ ♀
	10	250	50 ♀
		500	30 ♀
P-6904	1	415	20 ♀
	3	550	60 ♂ ♀
	12	781	5 ♀
	14	458	20 ♂
P-6911	2	533	20 ♂
	3	494	20 ♀

TABLE 72

Vertical distribution of *Nematoscelis tenella*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6701	2	500	20 ♀
P-6811	8	238	20 ♀
	11	285	75 ♀
		590	25 ♂
P-6904	4	470	25 ♀
	15	524	20 ♀
	18	531	20 ♀
	22	372	10 ♀
P-6911	4	218	40 ♂ ♀
	15	445	5 ♂

TABLE 73

Vertical distribution of Stylocheiron affine

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6701	3	0	10 ♀
		115	10 ♀
	10	110	250 ♀
	12	100	50 ♀
	13	100	50 ♀
	24	100	50 ♂
P-6803	20	75	20 ♂
P-6811	9	50	50 ♀
	18	114	50 ♀
P-6904	2	265	60 ♂ ♀
	3	265	60 ♂ ♀
	6	31	680 ♂ ♀ imm.
	7	25	100 ♂ ♀
	18	62	80 ♂ ♀
P-6911	5	237	100 ♀
	9	60	100 ♀

TABLE 74

Vertical distribution of Stylocheiron carinatum

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	4	103	700 ♂♀
		285	25 ♀
	8	100	500 ♂♀
P-6701	2	90	60 ♀
	5	0	50 ♀
	10	110	150 ♀
	11	110	50 ♀
P-6803	4	30	200 ♂♀
	17	100	40 ♀
P-6805	7	50	350 ♂♀
	9	0	250 ♀
	10	55	50 ♀
P-6904	11	45	200 ♂♀
		262	20 ♀
	13	48	200 ♀

TABLE 75

Vertical distribution of *Stylocheiron longicorne*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6701	2	500	20 ♀
	3	250	20 ♀
		350	10 ♀
	8	250	20 ♀
		505	10 ♂
G-6722	4	335	15 ♂ ♀
	9	155	20 ♂ ♀
		320	10 ♀
	12	181	40 ♂ ♀
	15	132	3 ♀
	17	250	10 ♀
P-6803	8	95	150 ♀
		175	30 ♀
	17	240	50 ♀
	20	235	30 ♀
	22	0	20 ♀
		200	30 ♀
P-6805	11	250	2 ♀
P-6811	2	237	200 ♂ ♀
	3	225	30 ♀
	5	250	100 ♂ ♀
	7	225	100 ♀
	8	238	20 ♀
	9	230	50 ♀
	11	45	100 ♀
		285	25 ♀
	15	470	5 ♀
	16	500	2 ♀
P-6904	7	241	20 ♀
	9	236	60 ♂ ♀
	11	262	60 ♂ ♀
	13	258	50 ♂ ♀
		1638	1 ♀

TABLE 75 (continued)

Vertical distribution of Stylocheiron longicorne

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
	17	251	40 ♀
	20	258	1 ♂
	21	50	400 ♂ ♀
		220	50 ♀
	22	372	30 ♂ ♀
P-6911	2	242	60 ♂ imm.
	3	274	200 ♂ imm.
	4	81	200 ♀
		218	40 ♂ ♀
	9	250	2 ♂
	10	227	40 ♀
	16	243	40 ♂ ♀

TABLE 76

Vertical distribution of *Stylocheiron suhmii*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6701	3	115	5 ♀
	12	100	50 ♀
	13	100	50 ♀
P-6805	5	96	40 ♂ ♀
P-6811	16	52	50 ♀
P-6904	1	38	450 ♂ ♀ imm.
	16	59	200 ♂ imm.
P-6911	5	59	30 ♂

TABLE 77

Vertical distribution of *Thysanopoda aequalis*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	4	103	100 ♀
P-6701	11	500	10 ♀
P-6803	15	400	10 ♀
	22	0	10 ♀
P-6805	2	100	50 ♀
	7	500	10 ♀
P-6811	8	480	10 ♀
P-6904	10	455	10 ♀
	13	48	50 ♀
	14	458	20 ♀
		734	15 ♂ ♀
	15	791	4 ♀
	21	50	50 ♀
	22	554	40 ♂ ♀
P-6911	1	65	50 ♀
	2	1272	2 ♀
	8	510	20 ♂

TABLE 78

Vertical distribution of _Thysanopoda obtusifrons_

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6803	22	200	30 ♂
P-6805	10	55	50 ♀
P-6811	2	237	50 ♂
	20	500	20 ♂
P-6904	3	550	30 ♂
	19	550	50 ♂ ♀

TABLE 79

Vertical distribution of *Thysanopoda tricuspidata*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6701	2	575	1 ♀
	11	500	1 ♂
P-6811	7	375	20 ♀
P-6904	22	372	10 ♀
P-6911	10	2660	1 ♀
	11	2490	1 ♀
	12	410	20 ♀

Chaetognatha

Introduction

The numerous records of chaetognath distribution in the Atlantic Ocean, made before March 1967, have been compiled in a Spanish publication by Alvariño (1969). Since then, the few studies in the Caribbean area have been cited by Owre & Foyo (1972), who wrote a very limited report on vertical distribution concerning 14 species, all of which were known from the western North Atlantic or the Caribbean. Owre (1973) recorded *Eukrohnia bathypelagica* Alvariño and *E. proboscidea* Furnestin & Ducret from the Caribbean for the first time and described *Bathybelos typhlops* from the Gulf of Mexico Basin. *E. bathypelagica* was first reported from the North Atlantic Ocean by Figueira (1972), who found a specimen in a vertical haul from 440 m at the entrance to the Gulf of St. Lawrence. Another recent work is a thesis titled "Chaetognaths of the Caribbean Sea" (Mattlin, 1974), in which 13 species, including one specimen of *Sagitta friderici* Ritter-Záhony from surface waters over the Cariaco Trench, a new record for the Caribbean, were reported. The 22 species listed here include another record, *Sagitta megalopthalma* Dallot & Ducret. Since our list does not include the neritic forms *S. tenuis* and *S. friderici*, the actual number of pelagic species known to occur in the Caribbean is 24.

Mattlin (op. cit.) collected samples with opening-closing nets over a maximum range of 0-550 m at three stations, one located over the Cariaco Trench off Venezuela, another in the central eastern Caribbean, and the third in the far western sector, south of Cuba. A total of five series of vertical tows, through 50 m sections of the water column, were made with the same type of net (0.5 m mouth diameter, 200 μm uniform mesh) which Owre & Foyo (1972) used on P 6602. They found it poor for collecting

soft-bodied forms. Mattlin reported that a major objective of his study, "...to evaluate the feasibility (sic) of using chaetognaths as bio-indicators of water masses in the Caribbean Sea" was unattainable because "...no distinct line of demarcation was transected, as would be the case, for example, on crossing the Florida Current..." Mattlin had too few data, not only across the Caribbean but also in the vertical dimension, to speculate about the usefulness of chaetognaths as labels. The present data show that several species are useful as indicators in tropical areas just as Pierce (1941, 1953), Russell (1935, 1936a, b, 1939) and others have found them to be in temperate areas.

Because the majority of the 22 species identified in our collections are relatively abundant and predictable in their vertical distribution, except for situations involving upwelling, sinking, or entrainment from coastal regions, detailed studies were limited to four cruises, selected for their coverage of the Caribbean (P 6606, 6805, 6811 and 6911). These samples provided data on vertical and horizontal displacement as well as the "normal" distribution in the open sea. Deep samples from other cruises were also examined in the hope of adding data on species infrequently caught. In particular, the samples from P 6803 in the Gulf of Mexico and the Yucatan Basin were studied, after finding Bathybelos typhlops Owre at Station 11. All hydrographic and biological data collected at that station are given in Tables 10 and 80. Also, to provide the comparative data on horizontal distribution given in Table 23, chaetognaths were counted in the samples from Station 2, P 6701 and Station 2, P 6904 (Yucatan Channel) and from Stations 15 and 17, G 6722 (Grenada Passage).

Excluding the rarely collected forms, the records of which are given in Table 81, the chaetognath species occurred in the following declining

order of abundance: Sagitta enflata, S. serratodentata, Pterosagitta draco, S. decipiens, S. hexaptera, Krohnitta pacifica, S. bipunctata, K. subtilis, S. hispida, S. lyra, S. minima, Eukrohnia bathyantarctica, E. bathypelagica, E. fowleri, S. macrocephala and S. zetesios.

TABLE 80

Organisms collected from the surface to 2500 m at Station 11, P 6803 in the Gulf of Mexico (see Table 16).

Species	Estimated or Actual Total Numbers Collected at						
	0 m	30 m	580 m	1030 m	1500 m	2000 m	2500 m
SIPHONOPHORA							
Abylopsis eschscholtzii	80	150	-	-	-	-	-
Diphyes bojani	-	100	-	-	-	-	-
Eudoxoides spiralis	-	50	-	-	-	-	4
Chelophyes appendiculata	-	-	-	-	-	-	4
COPEPODA							
Farranula carinata	1120	-	-	-	-	-	-
Clausocalanus furcatus	40	650	-	-	-	-	-
Paracalanus aculeatus	80	50	-	-	-	-	-
Microsetella rosea	480	-	30	-	4	-	48
Oithona plumifera	480	4150	180	-	2	4	28
Oncaea venusta	920	1100	30	-	-	-	12
Macrosetella gracilis	-	30	-	-	-	-	-
Undinula vulgaris	-	700	-	-	-	-	-
Euchaeta marina	-	5450	-	-	-	-	-
Scolecithrix danae	-	2400	-	-	-	-	8
Rhincalanus cornutus	-	-	270	66	42	-	8
Mormonilla minor	-	-	150	42	28	23	-
M. phasma	-	-	60	9	20	7	-
Conaea gracilis	-	-	630	42	52	8	16
Haloptilus longicornis	-	-	-	6	-	-	-
Aegisthus aculeatus	-	-	-	18	-	-	-
Oncaea mediterranea	-	-	-	3	4	-	8
Lucicutia flavicornis	-	-	-	-	-	-	4
EUPHAUSIACEA							
Euphausia americana	-	-	-	-	-	-	12
CHAETOGNATHA							
Sagitta enflata	470	180	-	-	-	-	-
S. serratodentata	280	220	-	-	-	-	-
S. bipunctata	190	-	1	-	-	-	-
Krohnitta pacifica	10	20	-	-	-	-	-
Pterosagitta draco	10	170	-	-	-	-	6
S. minima	-	150	-	-	-	-	-
S. lyra	-	-	1	-	-	-	2
S. macrocephala	-	-	8	3	4	3	1
Eukrohnia bathyantarctica	-	-	9	5	1	2	-
E. bathypelagica	-	-	8	-	-	-	-

TABLE 80 (continued)

Species	Estimated or Actual Total Numbers Collected at						
	0 m	30 m	580 m	1030 m	1500 m	2000 m	2500 m
S. hexaptera	-	-	-	1	-	-	1
Bathybelos typhlops	-	-	-	-	-	-	1
SALPIDAE							
Thalia democratica	40	100	-	-	-	-	-
Salpa fusiformis	-	-	120	-	-	-	-

Distribution

The most uncommon species in our collections were a few neritic and bathypelagic forms. The records of the more numerous ones, *Sagitta hispida* and *S. minima*, are listed in Tables 96 and 99, and those of five others, in Table 81. These species will be discussed later. *Bathybelos typhlops*, recently described from one specimen collected at 2500 m in the Gulf of Mexico Basin (Owre, 1973), perhaps is endemic to the deep Basin water. The more numerous species are distinctly stratified, forming groups which characterize the warm and cold water spheres in the Caribbean. Almost all of the species have extensive vertical ranges, according to our data as well as previously published information, but the greatest numbers of the commoner species congregate in a relatively restricted dimension. For example, *Pterosagitta draco* was most frequently found in the upper 100 m, although it was collected as deep as 2316 m (Table 91). Such records of epipelagic species from deep water may result from contamination. However, special care was taken to discard dessicated and obviously moribund specimens and to note the sexual development of the remainder. The numbers found at relatively great depths are always few and usually disjunct, and it is reasonable to eliminate them in a discussion of primary levels of distribution. All depth records are included in Tables 86 through 101 on vertical distribution of the more abundant species, but the depths at which they most often occurred are those of greatest interest in the present study. Considering the many inaccuracies inherent in plankton sampling with nets, we generalized the tabular data on vertical distribution, separating the commoner species into groups according to depth: those usually found in the 0-200 m and the 100-600 m ranges and those usually living below 500-600 m

TABLE 81

Distribution of five rarely collected species in the Caribbean

Species	Cruise	Sta. No.	Depth (m)	Total Numbers
Eukrohnia hamata	P 6811	2	822	8
	P 6911	1	715	9
E. proboscidea	P 6811	12	1100	1
		16	750	2
	P 6911	3	739	1
			2072	1
Sagitta helenae	P 6911	2	0	11
		6	0	3
S. megalopthalma	P 6811	3	0	7
		16	2550	1
S. planctonis	P 6911	3	739	1

(Table 82). A departure from the scheme of discrete strata used by most authors (e.g., Alvariño, 1964; Fagetti, 1972), this is an attempt to show that species living mainly below the upper 100 m in tropical areas, at least, are rarely restricted to these levels as such schemes suggest.

In a study of bathymetric distribution in the Indian and Pacific Oceans, Alvariño (1964) grouped the species on the basis of data from four types of collections: oblique hauls from 140 m, catches in closing nets or vertical tows at several levels from 270 to 868 m, and mid-water trawls down to 3000 m. The groupings are, (1) epiplanktonic, the upper 150-200 m, (2) mesoplanktonic, 200-1000 m, and (3) bathyplanktonic, below 1000 m. For comparison, the percentage of the more common species collected within each of these levels in the Caribbean is shown in Table 83. Over 90 percent of the first seven species occurred in the upper 200 m, and these are included in Alvariño's list of epiplanktonic species. However, two of her epiplanktonic species, *Krohnitta subtilis* and *Sagitta lyra*, were far more numerous in the mesoplanktonic strata of the Caribbean. *S. decipiens* and *S. zetesios* were classified as mesoplanktonic by Alvariño; the abundant *S. decipiens* is the only clearly mesoplanktonic species in our collections. *S. macrocephala*, which occurred in more samples than any other species, was almost evenly distributed in the mesoplanktonic and bathyplanktonic levels in the Caribbean but was considered mesoplanktonic in the Indian and Pacific Oceans. Alvariño's bathyplanktonic *Eukrohnia bathypelagica*, *E. bathyantarctica* and *E. fowleri* actually were predominantly mesoplanktonic in the Caribbean.

Fagetti (1972) also has described the bathymetric distribution of chaetognaths, in a study of plankton in the southeastern Pacific off Chile. The species were grouped in vertical categories similar to those used by Alvariño: 0-200 m, epiplanktonic; 500-1000 m, mesoplanktonic; and

TABLE 82

Summary of the vertical ranges of the more common chaetognath species in the Caribbean Sea, the total number of samples in which each occurred, the estimated total number collected, and the average number per sample collected in the standard hour-long tow.

	Total Range (m)	Range of maximum numbers	Number of Samples	Tot. Est. Numbers	Avg. No. Samples
"Epipelagic" species					
K. pacifica	0-1835	0-100	69	4,762	69.0
P. draco	0-2316	0-100	50	11,717	234.3
S. bipunctata	0-300	0-100	34	2,162	63.6
S. enflata	0-320	0-100	95	57,795	608.4
S. serratodentata	0-2000	0-100	102	31,331	307.2
S. hexaptera	0-1567	0-200	91	9,545	104.9
S. hispida	0-250	0-60	33	1,131	34.3
S. minima	0-590	-	8	165	20.6
"Mesopelagic" species					
K. subtilis	25-5200	100-500	71	3,495	49.2
S. decipiens	75-2650	200-500	90	13,183	146.5
S. lyra	25-3000	200-600	104	3,529	33.9
S. zetesios	38-3000	250-1000	27	69	2.5
"Bathypelagic" species					
E. bathyantarctica	230-3442	500-2000	44	275	6.2
E. bathypelagica	423-2118	450-1000	47	270	5.7
E. fowleri	635-2104	635-2104	55	195	3.5
S. macrocephala	472-3602	600-2500	106	471	4.4

bathyplanktonic, below 1000 m. Fagetti, too, classified Krohnitta subtilis and Sagitta lyra as epiplanktonic. In further contrast to records of distribution and abundance in Caribbean oceanic waters, S. minima was the second most numerous epiplanktonic form, S. enflata being first, and S. serratodentata was one of nine species representing less than 10 percent of the total catch. It should be noted that Fagetti's table of abundance of epiplanktonic forms contains several errors. Among them, the figures showing relative abundance in percentage total 117.8 percent. Fagetti's list of meso- and bathyplanktonic species is similar to ours except for the mesoplanktonic E. fowleri and S. macrocephala and the bathyplanktonic E. bathyantarctica which, as shown in Table 83, do not fit these depth zones in the Caribbean.

These facts illustrate the fallacy of using arbitrary vertical dimensions to characterize species living in temperate and tropical areas around the world, particularly when the physico-chemical nature of the water from which they have been collected is not considered. However, the terms epi-, meso- and bathypelagic or -planktonic are useful in a broadly descriptive sense. By referring to the vertical ranges found in an area, such as those listed in Tables 82 and 83, one can locate unusual records which indicate particular phenomena. For example, the occurrence of upwelling in deep water off the coast of Panama (Station 9, P 6811) is suggested by the presence of numerous S. lyra at 50 m, E. bathyantarctica at 230 m and S. macrocephala at 635 m (Tables 86, 97, 98). Upwelling was discussed in the section on physical and chemical data.

The surface waters and the Subtropical Underwater are characterized by six oceanic chaetognath species: Krohnitta pacifica, Pterosagitta draco, the relatively rare Sagitta bipunctata, the two most abundant species, S. enflata and S. serratodentata, and S. hexaptera which does not usually occur

TABLE 83

Vertical distribution of Chaetognatha in the Caribbean Sea, the species arranged in order of frequency of occurrence from the surface to depths below 1000 m.

Species	0-200 m		201-1000 m		> 1000 m	
	Numbers	Percent	Numbers	Percent	Numbers	Percent
P. draco	11701	99.8	16	<1	-	-
S. enflata	57683	99.8	112	<1	-	-
S. serratodentata	31047	99.1	284	<1	-	-
K. pacifica	4729	99.0	33	1	-	-
S. hispida	1119	98.9	12	1	-	-
S. hexaptera	8827	92.5	718	7.5	-	-
S. bipunctata	1987	92.0	175	8.0	-	-
K. subtilis	1342	38	2148	61	5	<1
S. lyra	964	27	2534	72	31	1
S. zetesios	13	19	53	77	3	4
S. decipiens	875	6	12300	93	8	<1
E. bathypelagica	-	-	247	92	23	8
E. bathyantarctica	-	-	214	78	61	22
E. fowleri	-	-	147	75	48	25
S. macrocephala	-	-	270	57	201	43

in surface water. The T-S-P diagrams show that most K. pacifica, S. bipunctata, S. enflata and S. serratodentata lived in warm waters of highly variable salinity (Figs. 36A, 37B, 38B and 41A) whereas the occurrence of P. draco and S. hexaptera was usually associated with the more saline Subtropical Underwater (Figs. 37A and 39A).

The least numerous epipelagic species caught in the open sea were Sagitta hispida, a natural inhabitant of inshore and neritic waters, and S. minima, of shelf and slope areas. The abundance of S. hispida in bays and shallow coastal waters from Cape Hatteras, N.C., southward along the Florida coast, in the Gulf of Mexico, the Bermuda lagoon, the Bahama Islands, and in the Caribbean off Jamaica, Cuba, Honduras and Venezuela is well documented (Conant, 1896; Legaré & Zoppi, 1961; Owre, 1960, 1972a; Pierce, 1951, 1962; Pierce & Wass, 1962; Suárez-Caabro, 1959; Suárez-Caabro & Madruga, 1960; and others). It also lives in Brazilian coastal waters (Owre & Foyo, 1972), and probably it is characteristic of shoal areas and embayments through the Lesser and Greater Antilles. The facts indicate that Alvariño (1969) erred in depicting its distribution as pan-Atlantic, -Caribbean, and -Gulf of Mexico. There is no evidence that communities of S. hispida are regular features of the open sea. It is a moderately euryhaline species in the Caribbean, found mostly in surface water at salinities in the range of 34.5 to 36.5°/₀₀ and warm temperatures (Fig. 39B). Probably records such as those in Table 96 result from mixing of coastal waters with upper layers of Atlantic water as they flow through island passages into the Caribbean to form the westward moving currents, and also as these currents sweep past the shoal areas off land masses such as Jamaica and Honduras (Fig. 2). The fact that the degree and frequency of such mixing depends on many variables, and that the size of the population

is known to fluctuate (Owre, 1960; Pierce, 1951) probably accounts for the spotty distribution of this species in the open sea. An explanation for each record can be postulated. For example, on P 6805, the largest number was found in a surface tow at Station 3 (Fig. 10), which is northwest of the huge shoal area, extending eastnortheast from Honduras and terminating in Rosalind Bank. The greatest depth separating these banks from Pedro Bank south of Jamaica and the Jamaican shoals is less than 1000 fms, and the entire area, extending from Honduras to Hispaniola forms the Jamaican Ridge (Fig. 2). Suárez-Caabro & Madruga (1960) found S. hispida the most common species in shallow areas off the northeast coast of Honduras. It is reasonable to expect that specimens periodically are entrained by the Caribbean Current, just as those found on the western side of the Florida Current probably come from the west coast of Florida or western Cuba or both (Owre, 1960). Similarly, Station 1 of P 6811 is in the Windward Passage, the specimens at Stations 3 and 4 could have come from shallow areas off the Antilles or South America, Stations 5, 7, 8, 10 and 12 are all within the Central American gyre, Station 14 is directly off Jamaican Banks, Station 20 is very near Cuba, and so on.

The records of S. minima (Table 99) are not easy to interpret. It was found at three of the same stations as S. hispida and at three others adjacent to stations at which S. hispida occurred. Although Alvariño (1969) again illustrated a pan-Atlantic distribution, it actually is a poorly known species usually found in greatest numbers in oceanic water at the edge of the continental shelf (Owre, 1960; Pierce & Wass, 1962). Its small size (to 7.9 mm in the Atlantic) doubtless accounts in part for the relatively few Atlantic records. Suárez-Caabro (1955, 1959) did not find it off the Cuban shelf nor did Suárez-Caabro & Madruga (1960) report it from

Honduras, their samples having been collected over the banks. However, Mattlin (1974) caught it from the surface to 350 m over the Cariaco Trench where it was most numerous between 150 and 250 m. Owre (1960) reported a similar depth range, with the maximum usually between 100 and 200 m. It probably occurs off the shelf areas of northern South America and perhaps the Antilles. Its presence at depths such as 590 and 494 m at 8.1 and 8.5°C and 34.9°/₀₀ (Sta. 11, P 6811 and Sta. 3, P 6911, Fig. 40B) seems to indicate entrainment of the animals in an up-welling of Subantarctic Intermediate Water. Otherwise, it occurred over a range of 0-274 m, 13.5-27.8°C and 35.6-36.6°/₀₀, in general agreement with previous records (Mattlin, 1974; Owre, 1960; Prado, 1961).

The most infrequently collected neritic species was S. helenae. According to Pierce & Wass (1962), its distribution appears to be limited to the tropics and subtropics of the western Atlantic, including the Gulf of Mexico, and the species is most numerous in shelf areas. Alvariño (1968) reported it from the region of Amazon influence off Brazil. The only two stations at which it was caught in the oceanic Caribbean were both within the Lesser Antillean Arc and showed the effects of the wet season in north-eastern South America (Table 81; P 6911, Sta. 2, 29.1°C, 34.31°/₀₀; Sta. 6, 28.8°C, 32.71°/₀₀). Obviously the species is a stray there, indicating the existence of strong coastal influence within the eastern Caribbean in the fall.

Living below the epipelagic species are four that span the greatest vertical range of all, extending from the upper through the middle layers and into the depths traditionally known as bathypelagic: Krohnitta subtilis Sagitta decipiens, S. lyra and S. zetesios (Tables 90, 93, 97 and 101). Their distribution spreads from the Tropical Surface Water through the Subtropical

Underwater into the Subantarctic Intermediate Water; all but K. subtilis were also collected in North Atlantic Deep Water. However, they were most frequently caught in the Subtropical Underwater, the Subantarctic Intermediate Water, and the mixed layers between them to which North Atlantic Central Water contributes (Figs. 36A, 38A, 40A and 41B). Even the rare S. zetesios occurred through this extensive range and, in fact, a relatively large number (eight immature specimens) was caught at 38 m in the Windward Passage in Tropical Surface Water (29°C, 36.6°/₀₀, Table 18, Sta. 1), the upward extreme for this group of species. Probably its presence at that level resulted from turbulence in the passage. The abundance of K. subtilis and S. lyra through such an extensive vertical range suggests that they are the most adaptable of all the oceanic chaetognath species in the Caribbean area. Although the distribution of S. decipiens likewise extends from the upper Subtropical Underwater into the North Atlantic Deep Water, it is the only species with a clear numerical maximum in the Subtropical Underwater and the mixture with North Atlantic Central Water beneath it (Fig. 38A). As pointed out earlier, it alone fits the traditional concept of a mesopelagic species.

The remaining four of the more abundant species were largely restricted to Subantarctic Intermediate Water and North Atlantic Deep Water. Like S. decipiens, over 90 percent of the specimens of Eukrohnia bathypelagica was caught between 200 and 1000 m. It occurred in deep North Atlantic Central Water, although most specimens were found in Subantarctic Intermediate Water (Fig. 42B). The similar but less extensive distribution of E. bathyantarctica is shown in Fig. 42A. E. fowleri and Sagitta macrocephala were restricted to Subantarctic Intermediate and North Atlantic Deep Waters (Figs. 42C and 42D).

Eukrohnia hamata was collected twice in SAIW. Although the species has extraordinary horizontal and vertical ranges, being epipelagic in polar waters and in temperate and tropical areas of upwelling, yet classifying as bathyplanktonic in low latitudes (Alvariño, 1964; David, 1958), it appears to be rare in the Caribbean, as is E. proboscidea (Table 81). The latter was described by Furnestin and Ducret (1965) from specimens collected at 1000 and 1100 m off southeast Africa and apparently has not been found since, except in the Caribbean collections (Owre, 1973). The scarcity of the two, compared with the other species of Eukrohnia suggests that waters from their areas of abundance contribute little to the deeper layers of the Caribbean. S. planctonis is similarly rare in the Caribbean, having been caught once in SAIW at a station where the closely related but somewhat more numerous S. zetesios also occurred, although at lesser depth (Tables 81 and 101).

Sagitta megalopthalma Dallot & Ducret, originally described from the Mediterranean and also found in the Gulf of Guinea, is here reported from the western North Atlantic for the first time. Dallot & Ducret (1969) termed it mesoplanktonic in the Mediterranean, occurring in small numbers between 100 and 700 m. However, the youngest specimens were caught in the upper 100 m and the records from the Gulf of Guinea were from trawls at 10 and 60 m at night. The two peculiar records from the Caribbean are listed in Table 81. The specimen from 2550 m is small, in good condition and apparently not a contaminant while the much larger one caught at the surface consisted only of the anterior half, 10 mm long, and perhaps was mature since the holotype, at 19.5 mm, was in stage III of sexual maturity. The Sagitta sp. reported by Mattlin (1974) from the upper 250 m over the Cariaco Trench is also S. megalopthalma. Of the 32 specimens collected,

23 were caught in the upper 50 m, and the majority of the total was juvenile, as were the 10 badly damaged specimens sent by Mattlin to the senior author for identification. They were contorted so that their total length could only be estimated at 6-8 mm (Table 84). In addition, S. megalopthalma has been found in the deep, southward flowing current beneath the Florida Current in the Straits of Florida, the planktonic fauna of which will be described in a forthcoming report (J. C. Stepien, personal communication).

Even at very small size, S. megalopthalma is a distinctive species, clearly different from S. bipunctata, with which Dallot & Ducret said it could most easily be confused. The most useful characteristics are: (1) the large eyes, with rectangular pigmented area of specific structure, (2) the vacuolar type of intestine, compared with the simple type in S. bipunctata, and (3) the arrangement of the anterior teeth "en chevron", rather than in a fan with the bases of the teeth adjacent, as in S. bipunctata. Further data on Caribbean specimens are assembled in Table 84. Although there was no hydrographic information from 2550 m at Sta. 16, P 6811, it can be assumed that the animal was caught in North Atlantic Deep Water. Measurements made at 2465 m at another position in the Yucatan Basin (Table 4) can be taken as approximations (4.13°C and 35.01°/₀₀). The total known ranges of these conditions for the species are 17.5-28.4°C and 35.33-36.6°/₀₀. Hooks numbered 6-9, anterior teeth 5-7 and posterior teeth 9-13.

TABLE 84

Measurements and counts of hooks and teeth of Sagitta megalopthalma from the Caribbean Sea.

Source	Length (mm)	T%	Hooks	Anterior Teeth	Posterior Teeth	°C	Salinity (°/oo)
P 6811, Sta. 3	>10	-	7-7	6-6	10-11	28.4	35.33
Sta. 16	5	26	8-8	5-5	9- 9	-	-
Mattlin (1974)	6-8	-	8-?	6-?	11- ?		
	6-8	-	8-9	6-?	11- ?		
	6-8	-	8-8	6-?	10-11	17.5-	36.3-
	6-8	-	8-8	6-?	11- ?	20.7	36.6
	6-8	-	6-7	6-6	10-11		
	6-8	-	7-7	6-?	12- ?		
	6-8	-	9-9	6-7	12-13		

The horizontal distribution of chaetognaths is of especial interest because they were the most numerous organisms studied aside from copepods. Collected at every station, they were present in all samples except a few from great depths. They were least numerous in samples caught in or near passages of entry and most abundant in the main body of the Caribbean and the areas of upwelling off Colombia, Panama and Costa Rica (Fig. 43). The numerical summary in Table 85 shows that the largest average numbers per station were collected in the upwelling areas and the central Caribbean. These figures may reflect a high reproductive rate during the wet season in the eastern Caribbean, as well as central areas, and also in the enriched waters of the Central American gyre, as suggested by the distribution of copepods and euphausiids.

The common oceanic epi- and mesopelagic species, such as Sagitta enflata, S. serratodentata, S. decipiens, S. hexaptera, S. lyra, Krohnitta pacifica, K. subtilis and Pterosagitta draco appear generally distributed across the Caribbean. Because their habitats are deeper, the distribution of Eukrohnia bathyantarctica, E. bathypelagica, E. fowleri and Sagitta macrocephala are not as well known in the world oceans. From the present data, it appears that these four are similarly widespread although probably not as numerous in these latitudes as the species living in the shallower, warmer waters. All of them, and S. zetesios, too, were collected in the North Atlantic and in the Old Bahama Channel between Cuba and the Bahamas (P 6911, Sta. 13-17).

TABLE 85

Data on horizontal distribution of chaetognaths, summarized from Table 23.

Location	No. of Stations	Range in No. Chaetognaths Collected	Avg. of Total No. Collected per Station
Yucatan Channel	4	736-2544	1439
Western Caribbean	8	838-5658	2068
Central Caribbean	6	855-9257	3450
Eastern Caribbean	14	586-6276	2443
Areas of upwelling	12	910-8600	3828
Passages	4	831-2019	1476

If there are chaetognath indicators of waters entering the Caribbean, they may be found among the rare oceanic species in the Caribbean, not among infrequently collected forms whose distribution is usually associated with land masses, such as S. helenae, S. hispida and S. minima, discussed earlier. These oceanic species are Eukrohnia hamata, E. proboscidea,

Sagitta megalopthalma and S. planctonis (Table 81). E. hamata, characterized by David (1958) as "...one of the classic examples of bipolar distribution with tropical submergence," is a numerous epipelagic form in polar seas but less frequent below 500 m in lower latitudes (David, 1958; Dunbar, 1942). Owre (1960) reported collecting two specimens in the Florida Straits off Miami. In David's (1956) work on the taxonomic and distributional problems of S. planctonis, S. zetesios and S. marri, he described S. planctonis as "a surface living form breeding at a moderate depth (1000-750 m)" and recorded from various parts of the Atlantic and Pacific Oceans. Moore (1949) found it "not common" but with a strong spring maximum off Bermuda while Owre (1960) found only two specimens in collections from the Florida Straits. E. proboscidea and S. megalopthalma have recently been described, and little is known of their distribution. Evidently, none of these four species has become established in the oceanic Caribbean. It appears that the specimens collected are strays from populations in the North Atlantic and that, if niches are available, sufficient density has yet to develop within the Caribbean.

Many of the stations at which these forms were collected are in or near passages through which North Atlantic waters may enter the Caribbean; some are in the western Caribbean, to which animals entering through the Windward Passage would probably be carried by prevailing currents at all depths above the sill. To summarize these data, E. hamata was collected in relatively large numbers from SAIW both within the Anegada Passage and east of Jamaica, where waters entering the Windward Passage may influence the generally westerly movement of the Caribbean Current and deeper currents. The data at the depths of collection were, respectively, 715 m, 7.2°C and 34.87‰, and 822 m, 6.5°C and 34.86‰. In 1907, Fowler observed that

E. hamata had not been recorded from water warmer than 12.7°C. The temperature at 213 m in the Florida Straits, near the depth (225-275 m) at which one specimen was collected by Owre (1960) was 7.4°C. E. proboscidea occurred in SAIW and NADW at stations in the western Caribbean and also at two depths at P 6911, Station 3, located within passages between the Lesser Antilles and closest to that between Dominica and Martinique. The one specimen of S. planctonis was found with E. proboscidea at the latter station. The records of S. megalopthalma at P 6811, Stations 3 and 16, possibly are linked to inflow through the Windward Passage. In addition, evidence that reproducing populations exist in the southern Caribbean was provided by Mattlin (1974), who found juveniles to be fairly numerous in shallow waters over the Cariaco Trench. One can assume that a breeding population is present, perhaps at a greater depth than the 500 m sampled. This may mean that either the species is established in areas along northern South America and Central America which have not been investigated or else it has not been recognized.

The broad distribution of S. zetesios is the most puzzling of all the uncommon species. Although never numerous, it was caught in nearly every part of the Caribbean and also at a station in the Old Bahama Channel. However, with one exception (P 6811, Sta. 5), the relatively large numbers were found in or near passages through which North Atlantic water may enter: the Windward Passage (P 6811, Sta. 1), the Mona Passage (P 6911, Sta. 12), near the Mona Passage within the Caribbean (P 6911, Sta. 10), the Anegada Passage (P 6911, Sta. 1) and passages in the Lesser Antilles (P 6911, Sta. 3 and 4). Known as a cosmopolitan, mesopelagic form, occurring in the Atlantic, Pacific and Indian Oceans (Alvariño, 1965), it may not yet have established a breeding population in the Caribbean.

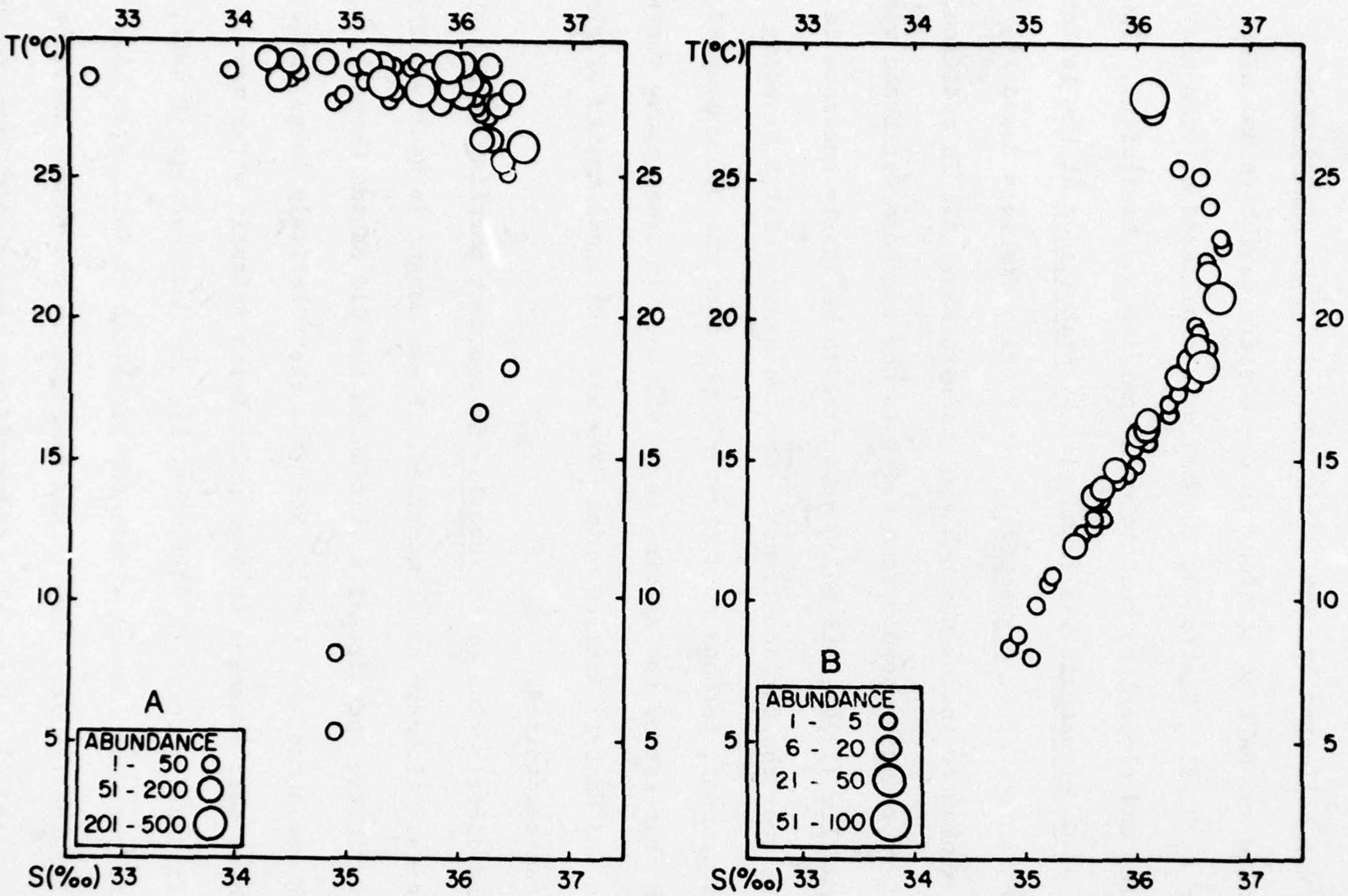

Figure 36. T-S-P diagrams, (A) _Krohnitta pacifica_ and (B) _K. subtilis_

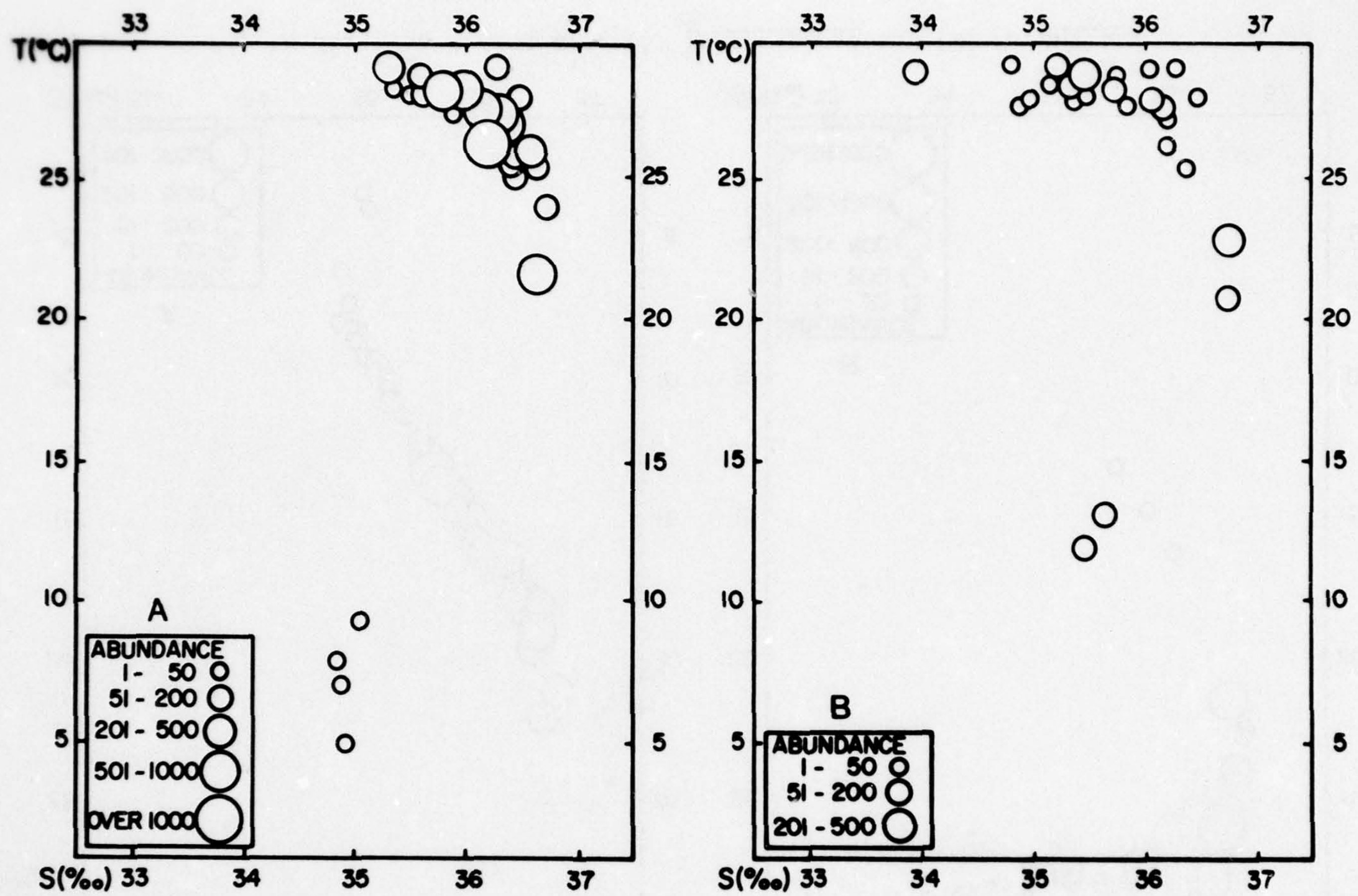

Figure 37. T-S-P diagrams, (A) <u>Pterosagitta draco</u> and (B) <u>Sagitta bipunctata</u>

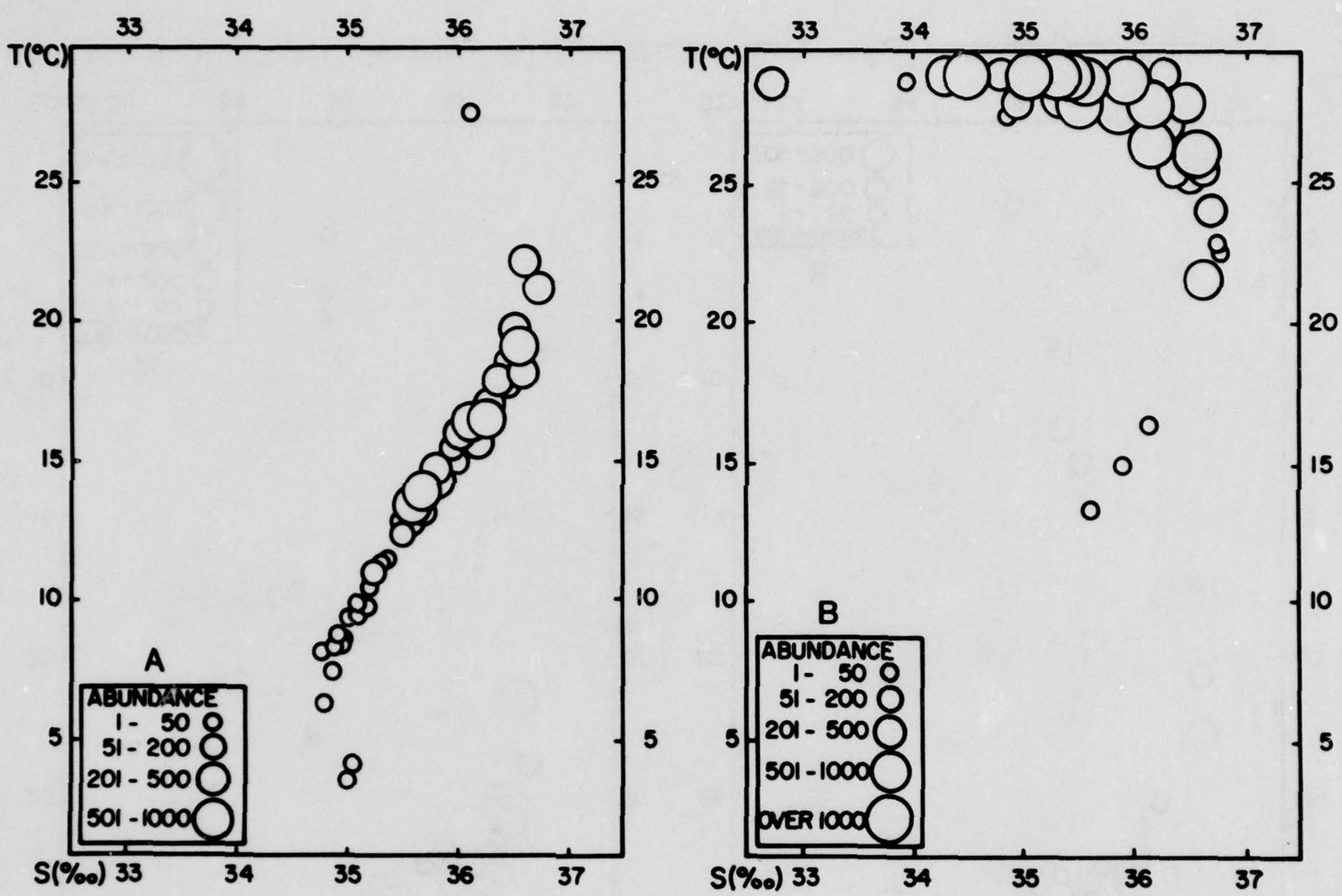

Figure 38. T-S-P diagrams, (A) S. decipiens and (B) S. enflata

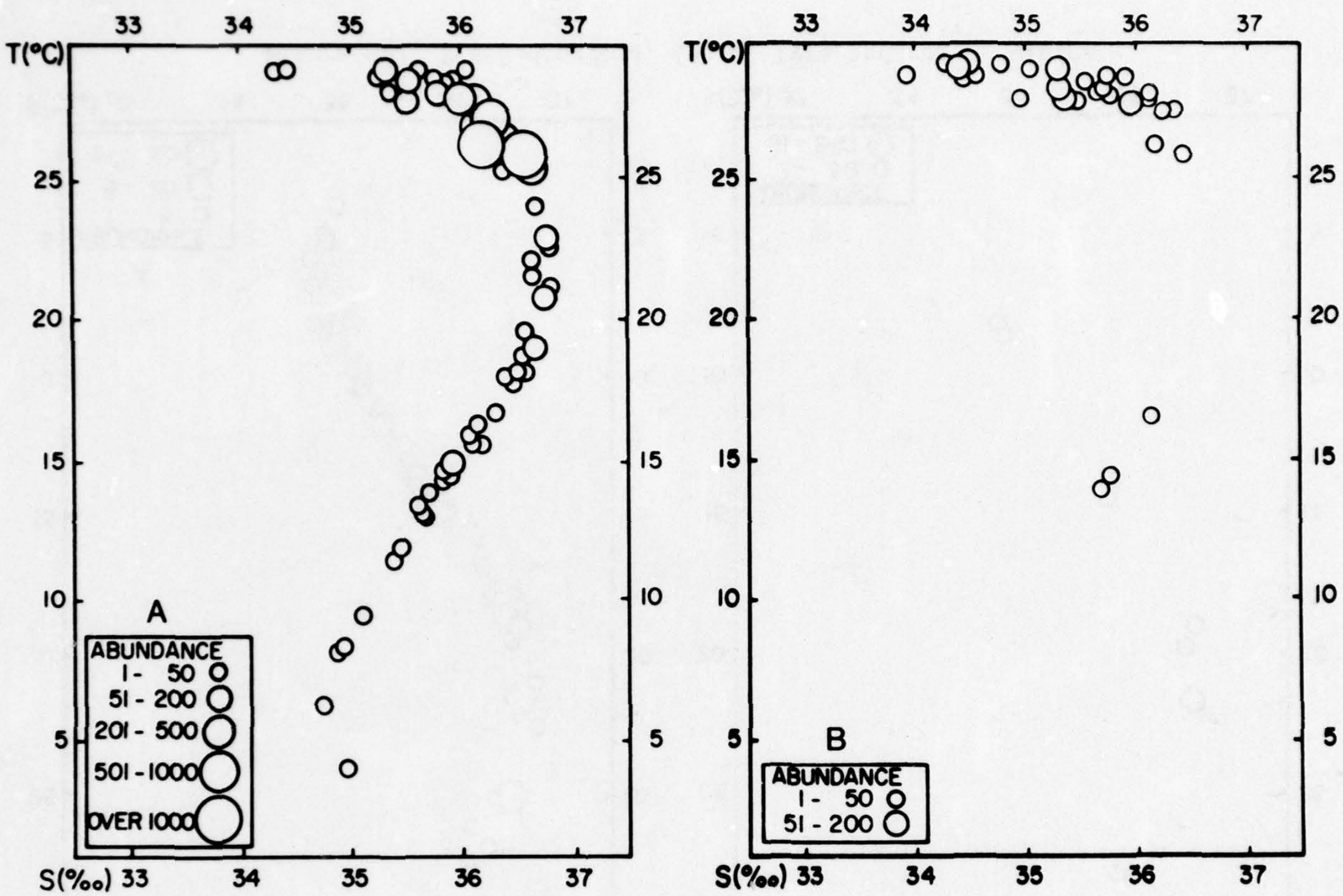

Figure 39. T-S-P diagrams, (A) S. hexaptera and (B) S. hispida

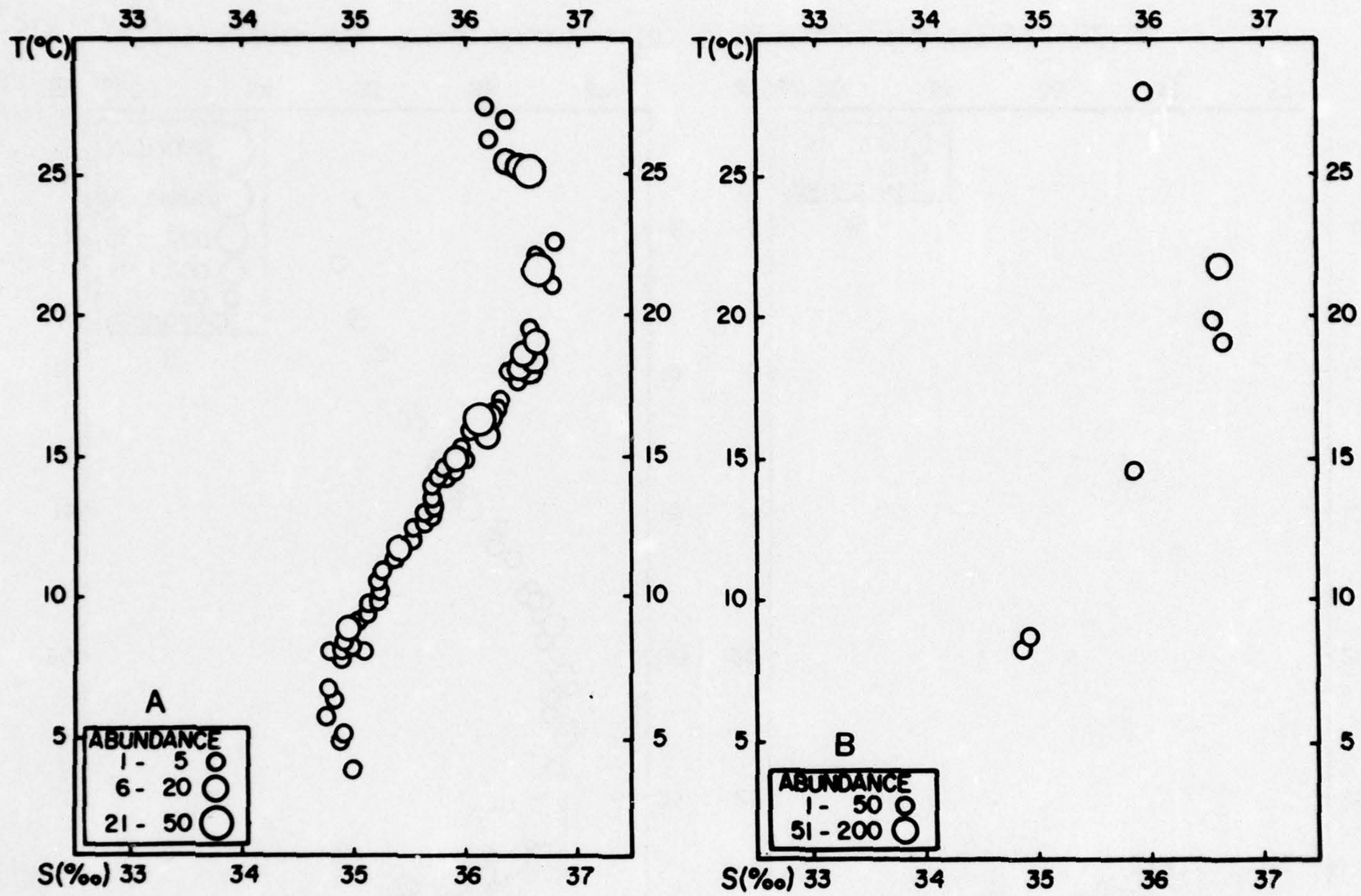

Figure 40. T-S-P diagrams, (A) _S. lyra_ and (B) _S. minima_

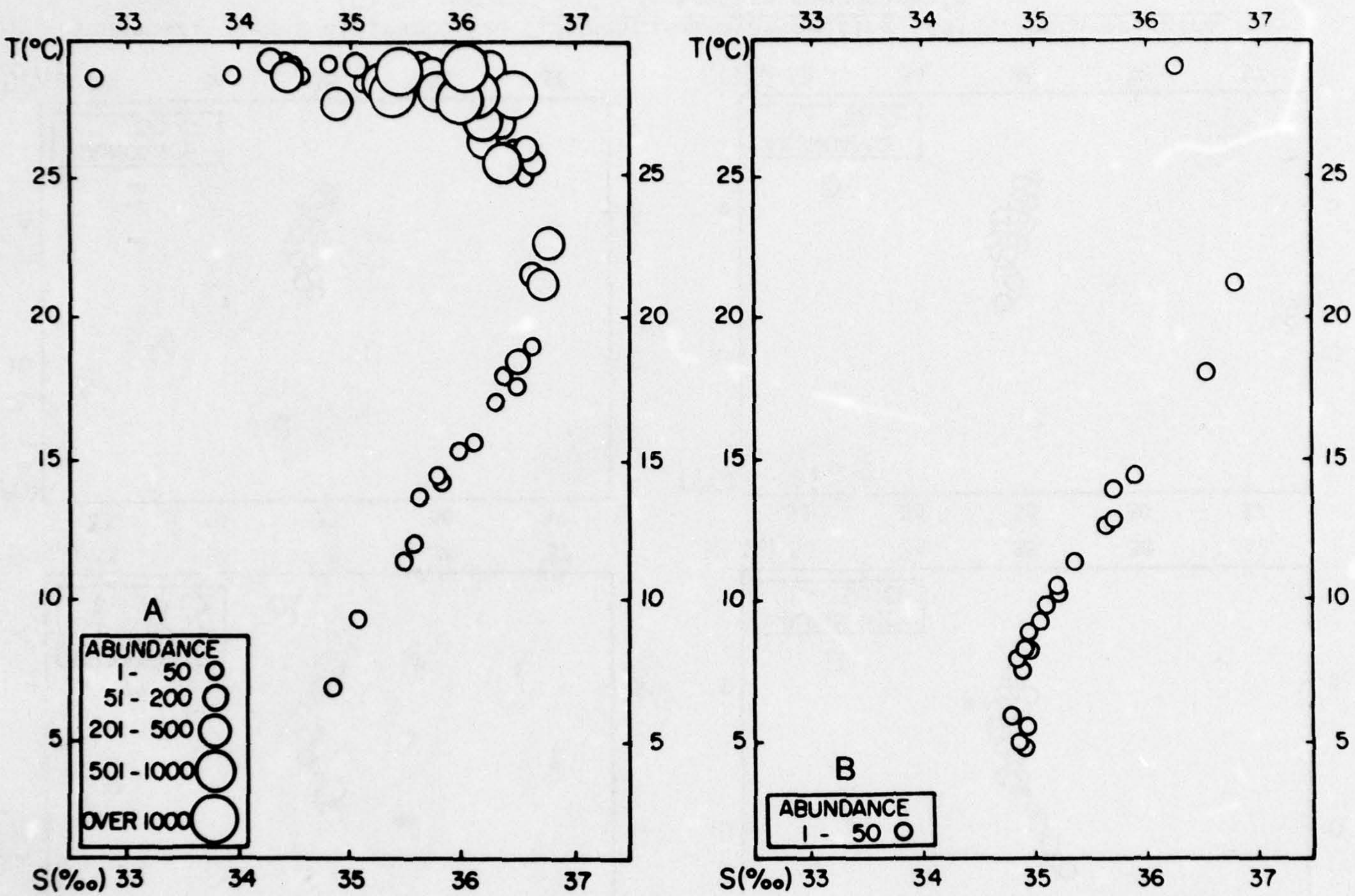

Figure 41. T-S-P diagrams, (A) S. serratodentata and (B) S. zetesios

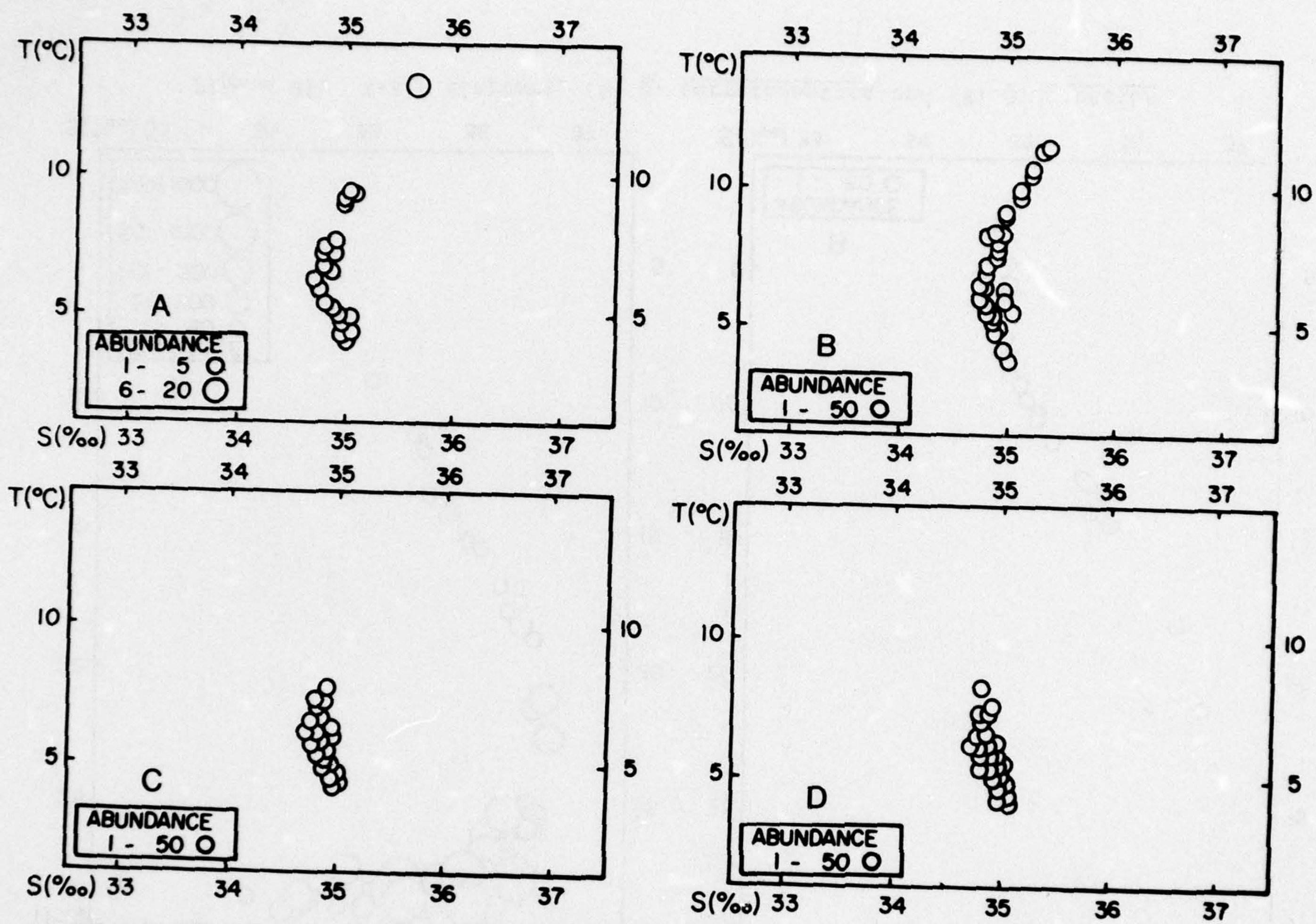

Figure 42. T-S-P diagrams, (A) <u>Eukrohnia bathyantarctica</u>, (B) <u>E. bathypelagica</u>, (C) <u>E. fowleri</u> and (D) <u>Sagitta macrocephala</u>

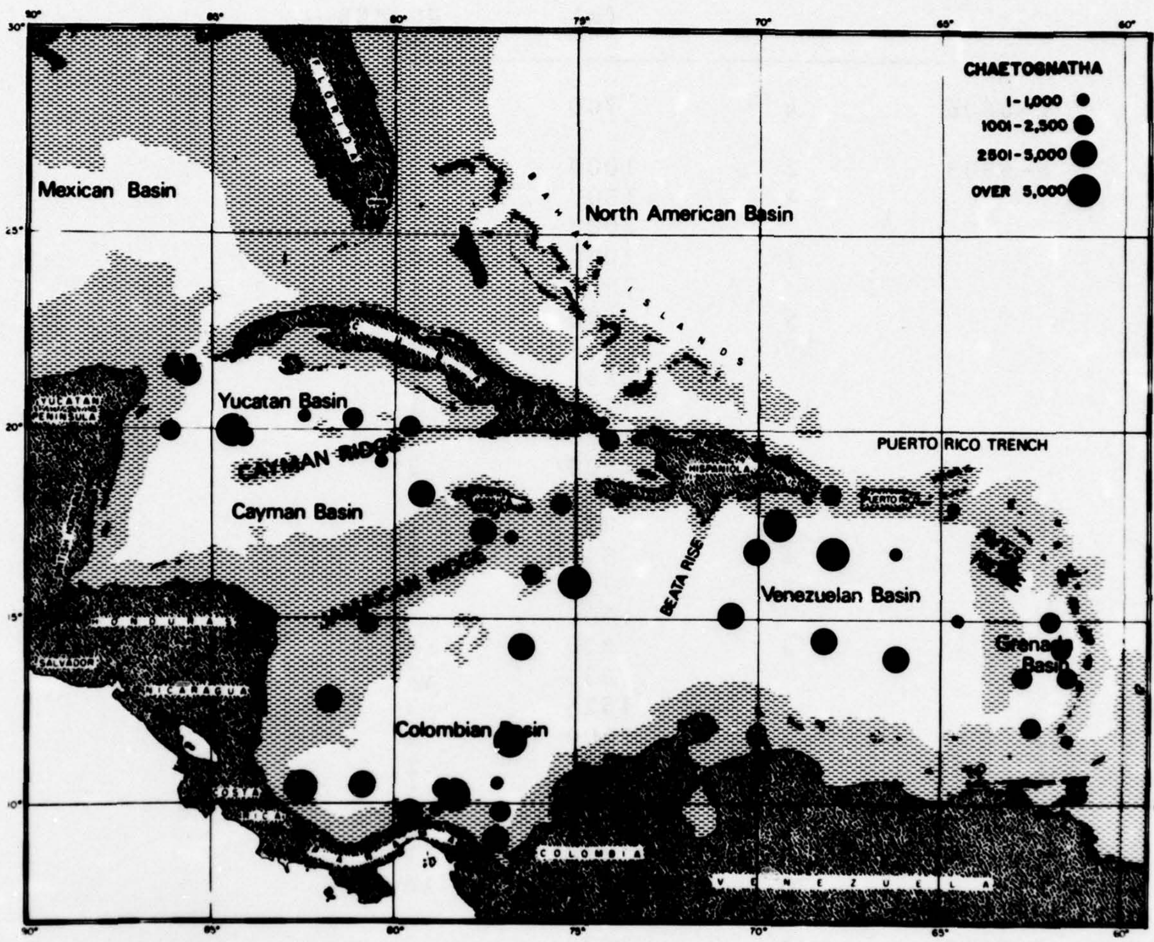

Figure 43. Total numbers of Chaetognatha collected at 48 stations selected to compare abundance in major Caribbean areas (see Table 23)

TABLE 86

Vertical distribution of *Eukrohnia bathyantarctica*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	4	700	10
P-6805	2	1000	2
	4	1500	1
		2000	1
	7	1000	30
		1500	1
	9	500	4
	10	477	2
		2256	2
	11	537	1
		1050	2
		1700	2
P-6811	2	822	2
	4	550	2
	8	713	3
		1500	2
	9	230	114
		635	12
		1525	2
	12	1100	4
	14	1700	1
	15	1325	1
	16	750	1
		2150	1
	20	750	10
P-6911	1	1371	3
		1835	1
		2337	1
	2	1272	5
	3	1567	4
	5	2474	1
	6	665	4
		888	1
	7	779	14

TABLE 86 (continued)

Vertical distribution of Eukrohnia bathyantarctica

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
		1300	8
	8	995	2
		1548	2
		2316	1
	9	1006	3
		1580	5
		2454	3
		3442	1
	10	2118	1
	13	1601	2

TABLE 87

Vertical distribution of *Eukrohnia bathypelagica*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6811	1	950	5
	2	508	1
	3	500	3
	4	550	3
		1050	3
	5	500	8
	6	720	5
	7	500	13
	8	480	4
		713	5
		1000	1
	9	635	30
	10	500	5
		1000	2
	11	590	8
		800	3
		1400	1
	12	1100	3
	16	750	1
	19	700	6
P-6911	2	533	11
		844	6
	3	494	6
		739	16
		1040	6
	4	423	6
		836	6
	5	472	10
		996	2
	6	481	24
		888	1
		1324	2
	7	539	2
		779	3
		1000	17
	8	510	8

TABLE 87 (continued)

Vertical distribution of Eukrohnia bathypelagica

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
	9	1006	3
	10	480	1
		975	4
		1500	1
		2032	1
		2118	1
	11	491	1
	14	785	8
	15	970	12
		1998	1
	17	1039	1

TABLE 88

Vertical distribution of *Eukrohnia fowleri*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	11	2000	5
P-6805	9	981	5
	10	995	1
		1500	1
	11	1050	5
P-6811	1	950	20
		1380	2
	2	822	3
		1000	2
	3	770	2
		1450	1
	6	720	6
		1000	1
	8	713	8
		1000	2
		1500	9
		2000	2
	9	635	18
		1400	1
		1525	1
	10	900	2
		1000	3
	11	800	1
	12	775	2
	14	800	1
		1700	1
	15	1000	3
	16	750	3
		1000	1
	17	714	1
		1000	10
		1500	1
	18	763	3
	19	800	1
P-6911	1	715	6

TABLE 88 (continued)

Vertical distribution of Eukrohnia fowleri

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
		911	5
	2	844	4
	3	739	2
		1040	6
	4	836	1
		1338	1
	5	698	2
		996	5
	6	665	5
		888	2
		1324	4
	7	779	3
		1300	2
	10	975	1
	11	969	2
		1570	2
		2104	3
	13	1036	1
	14	785	7
	15	970	3

TABLE 89

Vertical distribution of *Krohnitta pacifica*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	4	103	100
		285	25
	11	0	100
	13	0	100
	14	10	50
P-6805	2	0	50
	3	0	150
	4	90	50
	7	0	100
		50	500
P-6811	1	0	70
		38	80
	2	0	10
	3	0	231
	4	0	20
		50	20
	5	0	40
		25	100
	6	0	48
		25	10
	7	0	10
		90	60
		225	6
	8	0	3
		27	72
	9	0	5
	10	0	120
	11	0	140
		45	15
		590	1
	12	0	6
		35	40
	14	0	240
		40	15
	15	0	144

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TABLE 89 (continued)

Vertical distribution of Krohnitta pacifica

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
		55	102
	16	52	24
	19	0	100
	20	0	12
P-6911	1	0	5
		1835	1
	2	0	7
		53	30
		242	4
	3	0	2
	4	0	5
		81	21
	5	0	4
	6	0	18
		50	80
	7	0	8
		60	4
	9	0	120
		60	40
		1006	1
	10	0	30
		56	50
	11	0	20
		58	180
	12	0	10
		36	72
		78	10
	13	0	110
	14	0	50
		34	660
	15	0	70
	16	0	90
		51	51
	17	54	40

TABLE 90

Vertical distribution of *Krohnitta subtilis*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	8	100	50
	11	100	300
	12	100	50
		300	100
	13	100	25
P-6805	2	250	20
	4	250	18
	5	96	20
		250	240
	9	250	2
P-6811	1	250	12
		750	5
	2	77	70
		237	75
	3	225	49
	4	270	48
	5	250	144
	6	250	54
		485	8
	7	90	36
		125	33
		225	78
		275	12
		375	8
	8	238	84
	9	50	110
	10	25	630
		250	144
	11	285	90
	12	160	11
		290	20
		550	1
	14	285	20
	15	237	3
		470	1

TABLE 90 (continued)

Vertical distribution of Krohnitta subtilis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
	16	250	152
		500	3
	17	237	54
		485	40
	18	260	30
	19	320	84
	20	250	4
P-6911	1	250	2
		459	20
	2	242	16
	3	274	9
	4	81	7
		218	40
		423	2
	5	237	48
	7	253	40
	8	243	20
	9	250	95
	10	227	26
		480	1
	11	234	25
		491	2
	12	296	10
		344	10
		410	6
		465	6
	13	269	28
		500	6
		5200	1
	14	265	1
	15	224	25
		445	9
	16	243	18
		478	7
	17	261	58
		514	19

TABLE 91

Vertical distribution of *Pterosagitta draco*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	4	0	100
		103	200
		700	10
P-6805	2	100	150
	4	90	150
	7	0	200
		50	500
	9	0	50
		65	350
		500	2
	10	55	200
P-6811	1	38	128
	2	77	85
	4	0	15
		50	780
	5	25	2050
	7	90	12
	8	27	64
	9	50	520
	10	25	390
		500	1
	11	45	105
	12	35	860
	14	0	165
		40	195
	15	55	3
	16	52	36
		1000	1
	18	0	150
	19	0	20
	20	75	126
P-6911	1	65	35
	2	53	12
	3	60	540

TABLE 91 (continued)

Vertical distribution of Pterosagitta draco

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
	4	81	182
	5	59	30
		1878	1
	6	50	10
	7	60	52
	8	60	128
		2316	1
	9	60	180
	10	56	190
	11	58	320
	12	36	6
		78	75
	13	65	1210
	15	53	570
	16	51	237
	17	54	320

TABLE 92

Vertical distribution of Sagitta bipunctata

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	4	0	100
	8	0	100
	11	100	150
	12	0	350
		100	250
		300	100
	13	0	200
		300	75
P-6805	3	0	50
	7	50	50
P-6811	1	0	20
		38	24
	2	0	3
	3	0	70
	4	0	10
		50	60
	5	25	50
	6	0	12
	7	0	110
		90	36
	8	0	9
	9	0	20
	10	0	45
		25	30
	11	0	40
		45	15
	12	0	78
	15	0	24
	16	52	24
	17	0	1
	19	0	40
		75	2
	20	0	8
P-6911	7	0	6

TABLE 93

Vertical distribution of *Sagitta decipiens*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	4	593	10
	13	300	75
	14	100	450
P-6805	2	250	120
		1500	1
	3	250	250
	4	250	7
	5	250	280
		340	420
	7	2650	1
	9	250	32
		500	7
	10	245	150
		477	7
	11	250	550
		537	1
		2263	2
P-6811	1	250	72
		500	112
	2	237	540
		508	4
	3	225	175
		500	2
	4	270	256
		550	2
	5	250	496
		500	12
	6	250	270
		485	20
	7	125	390
		225	564
		275	180
		375	58
	8	238	300
		480	6

TABLE 93 (continued)

Vertical distribution of <u>Sagitta decipiens</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
	9	230	582
	10	250	552
	11	285	372
	12	160	16
		290	104
		550	3
	15	237	147
	16	250	456
		500	3
	17	237	222
		485	60
	18	260	240
		525	40
	19	320	420
		700	6
	20	75	7
		250	34
		750	10
P-6911	1	250	102
		459	30
	2	242	160
		533	4
	3	274	366
	4	218	200
		423	23
	5	237	568
		472	1
	6	481	8
	7	253	235
	8	243	52
		510	4
	9	250	280
		515	6
	10	227	352
		480	7
		2118	3

TABLE 93 (continued)

Vertical distribution of *Sagitta decipiens*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
	11	234	205
		491	3
	12	153	7
		200	5
		258	24
		296	540
		344	188
		410	70
		465	23
	13	269	150
		500	5
	14	265	1
	15	224	115
		445	81
		1998	1
	16	243	88
		478	34
	17	261	120
		514	26

TABLE 94

Vertical distribution of Sagitta enflata

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	4	0	100
		285	50
	8	0	350
		100	200
	11	0	100
	12	0	200
		100	50
	13	0	50
		100	25
	14	10	2450
P-6805	2	0	250
		100	250
	3	0	2150
		100	400
	4	0	50
		90	100
	5	0	1800
		96	20
	7	0	1000
		50	3650
	9	0	850
		65	600
	10	0	1250
		55	250
		245	50
	11	0	1380
P-6811	1	0	380
		38	448
	2	0	45
		77	220
	3	0	49
		63	1
	4	0	75
		50	1980
	5	0	480

TABLE 94 (continued)

Vertical distribution of *Sagitta enflata*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
		25	1100
	6	0	450
		25	240
	7	0	22
		90	348
	8	0	222
		27	144
	9	0	15
		50	760
		230	6
	10	0	180
		25	1230
	11	0	300
		45	390
	12	35	1020
	14	0	1390
		40	960
	15	0	1050
		55	252
	16	52	174
	17	85	250
	18	0	50
		114	150
	19	0	380
		75	1
		320	6
	20	0	14
		75	210
P-6911	1	0	55
		65	165
	2	0	819
		53	828
	3	60	210
	4	0	235
		81	329
	5	0	11

TABLE 94 (continued)

Vertical distribution of *Sagitta enflata*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
		59	800
	6	0	297
		50	580
	7	0	2
		60	60
	8	60	448
	9	0	2260
		60	2070
	10	0	1290
		56	1130
	11	0	930
		58	3940
	12	0	102
		36	380
		78	210
	13	0	610
		65	780
	14	0	365
		34	3240
	15	0	660
		53	1480
	16	0	291
		51	273
	17	54	328

TABLE 95

Vertical distribution of *Sagitta hexaptera*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	4	103	100
	8	0	50
		100	50
	11	100	200
	12	100	200
		300	25
	13	100	25
		300	25
P-6805	2	250	20
	5	96	20
		340	30
	7	50	2150
	9	0	400
		65	300
		250	9
	10	0	50
		55	300
		245	140
	11	0	90
		250	50
P-6811	1	0	10
		250	3
	2	77	40
		237	20
		508	1
	3	225	7
	4	50	300
		270	16
	5	25	1600
		250	24
	6	25	8
		250	30
	7	90	12
		125	3
		225	30

TABLE 95 (continued)

Vertical distribution of Sagitta hexaptera

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
	8	27	14
		238	24
	9	50	20
		230	36
		450	2
	10	25	510
		250	16
	11	0	20
		45	135
		285	6
	12	35	120
		160	4
		290	2
		1100	1
	15	237	12
	16	52	54
		250	16
		500	1
	18	114	50
	19	0	10
		320	18
	20	75	245
P-6911	1	0	5
		65	10
		250	4
	2	0	7
		53	24
		533	1
	3	60	170
		274	12
		494	2
		739	1
		1567	2
	4	81	259
	6	50	20
		1324	1
	7	60	4
	8	60	104

TABLE 95 (continued)

Vertical distribution of *Sagitta hexaptera*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
	9	60	30
	10	56	120
	11	0	10
		58	60
	12	78	20
		153	5
		344	2
	13	65	510
		269	4
	14	0	5
		34	20
	15	53	225
		224	110
	16	51	45
		243	8
		478	5
	17	54	84
		261	2

TABLE 96

Vertical distribution of *Sagitta hispida*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6805	3	0	150
	4	0	50
	11	0	1
P-6811	1	0	40
	3	0	70
	4	0	35
	5	0	40
		25	50
	7	0	2
	8	0	21
	10	0	75
		25	30
		250	8
	12	0	48
	14	40	15
	20	0	2
P-6911	1	0	20
	2	0	14
	5	0	3
		237	4
	6	0	6
		50	10
	9	0	80
	10	0	20
		56	10
	11	0	90
		58	120
	12	36	9
		78	10
	13	0	30
	14	34	20
	15	0	15
	16	51	33

TABLE 97

Vertical distribution of *Sagitta lyra*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	4	593	20
		1000	10
	11	2000	5
	12	300	25
	13	100	50
		300	50
P-6805	2	250	20
		440	3
	3	100	100
		250	150
		1583	1
	4	250	8
	5	96	240
		250	160
		340	90
	7	500	1
	9	250	6
	10	245	100
		477	7
	11	250	500
		537	2
P-6811	1	250	69
		500	46
		750	15
	2	237	45
		508	3
		822	1
	3	225	35
		500	2
	4	50	20
		270	12
		550	3
		1050	1
		3000	2
	5	25	50

TABLE 97 (continued)

Vertical distribution of *Sagitta lyra*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
		250	24
		500	4
	6	250	30
		485	60
	7	90	72
		125	6
		225	30
		275	6
		375	6
		500	2
	8	480	20
	9	50	410
		450	9
		635	6
	10	500	7
	11	590	1
	12	160	2
		290	4
	14	590	5
	15	237	6
	16	250	56
		500	1
	17	237	12
	18	525	40
	19	320	36
	20	250	6
		500	60
P-6911	1	250	30
		459	18
	2	242	28
		533	4
		844	2
		1272	1
	3	60	10
		274	18
		494	4

TABLE 97 (continued)

Vertical distribution of *Sagitta lyra*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
		1040	1
		1567	20
	4	218	15
		423	24
	5	237	28
		472	7
	6	481	24
	7	253	15
		779	1
		1000	4
	8	243	8
		510	20
	9	250	35
		515	3
	10	227	30
		480	14
	11	234	40
		491	6
	12	153	3
		200	1
		258	2
		296	80
		344	14
		410	8
		465	10
	13	269	26
		500	17
	14	520	4
	15	224	90
		445	15
	16	243	18
		478	22
	17	261	28
		514	8

TABLE 98

Vertical distribution of *Sagitta macrocephala*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	4	1000	10
	13	1000	5
P-6805	2	1000	3
		1500	1
	3	1583	1
		2400	6
	4	1010	1
		1500	1
	7	1000	20
		2300	4
	9	981	2
		1438	4
		2026	5
	10	995	5
		1500	1
		2256	1
	11	1050	11
		1700	4
		2263	1
		2550	1
P-6811	1	950	5
		1380	1
	2	822	3
		1000	3
	3	770	1
	4	1050	1
		1800	1
		2150	1
		3000	3
	5	1823	2
		2450	1
	6	720	1
		2025	4
	8	713	2
		1000	9

TABLE 98 (continued)

Vertical distribution of <u>Sagitta macrocephala</u>

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
		1500	1
		2000	7
		2450	1
	9	635	27
		1525	8
	10	750	6
		1000	10
	11	800	4
		1400	1
	12	775	3
		1100	3
	14	800	3
	15	1000	3
	16	750	3
		1000	3
		1500	3
	17	1000	20
		1500	3
		1950	1
		2375	3
	18	763	3
		1050	2
		2500	3
	19	700	6
		800	1
		1250	4
		1500	1
		1625	2
		1850	2
P-6911	1	715	3
		911	13
	2	844	7
	3	739	14
		1040	12
		1567	5
		2072	3

TABLE 98 (continued)

Vertical distribution of *Sagitta macrocephala*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
	4	836	15
		1338	1
		1844	3
	5	472	1
		698	3
		996	13
		1878	3
		2474	3
	6	665	4
		888	5
		1324	3
	7	779	2
		1300	5
	8	995	2
		1548	2
		2088	1
	9	1006	6
		1580	4
		2454	3
	10	975	1
		1500	1
		2032	6
		2118	16
		2660	3
	11	969	5
		1570	2
		2104	1
		2490	5
		3602	2
	13	1036	2
	14	785	8
		954	6
		1443	2
	15	970	7
	17	1039	6

TABLE 99

Vertical distribution of *Sagitta minima*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6805	3	0	50
P-6811	3	225	7
	9	50	60
		230	6
	11	590	2
P-6911	3	274	15
		494	10
	15	224	15

TABLE 100

Vertical distribution of Sagitta serratodentata

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	4	700	10
	8	0	150
		500	50
		2000	5
	11	0	50
	12	0	7200
		100	50
	13	100	275
	14	10	650
		100	400
P-6805	2	0	600
		250	40
		440	1
	3	0	2200
	4	0	200
		90	200
	5	0	800
		96	20
		500	3
	7	0	900
		50	150
	9	0	300
		65	50
	10	55	100
	11	0	30
P-6811	1	0	220
		38	224
	2	0	10
		77	70
	3	0	609
	4	0	140
		50	60
	5	0	960
		25	350
	6	0	102

TABLE 100 (continued)

Vertical distribution of *Sagitta serratodentata*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
		25	14
	7	0	10
		90	972
	8	0	117
		27	18
	9	0	385
		50	60
	10	0	2830
		25	1020
	11	0	2240
		45	720
		285	6
	12	0	72
		35	60
		160	7
	14	0	330
		40	180
	15	0	60
		55	54
	16	52	198
	17	85	150
		237	90
	18	0	350
		114	150
	19	0	120
	20	0	108
		75	91
P-6911	1	0	30
		65	20
	2	0	42
		53	144
	3	60	450
		274	6
	4	0	35
		81	126
		218	5

TABLE 100 (continued)

Vertical distribution of Sagitta serratodentata

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
	5	0	1
		59	40
		237	8
		1878	1
	6	0	3
		50	180
	7	0	36
		60	200
		253	5
	8	60	88
		243	32
	9	0	40
		60	20
		250	5
	10	0	100
		56	190
		227	12
	11	0	160
		58	140
	12	36	15
		78	70
	13	0	150
		65	375
	14	0	140
		34	260
	15	0	225
		53	75
		224	5
	16	0	234
		51	24
	17	54	48

TABLE 101

Vertical distribution of Sagitta zetesios

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6805	4	250	1
	10	477	1
		995	1
	11	537	2
		1050	1
P-6811	1	38	8
	2	508	1
	4	550	1
		1050	1
		3000	1
	5	500	10
	7	500	1
	10	500	1
	11	800	1
	12	290	1
	16	750	1
P-6911	1	911	4
	3	494	4
	4	423	4
	8	510	1
	10	480	10
	11	491	2
	12	153	5
		465	2
	13	500	1
	17	261	2
		514	1

Salpidae

Yount (1954, 1958) made the most comprehensive study of the taxonomy and distribution of salps in recent years. His work was based on samples collected from the central Pacific in oblique tows from 200 m to the surface. Nineteen of the 22 known species were identified in the collections. With the exception of four reported to be restricted to certain oceanic areas (*Ihlea magalhanica*, *Thalia longicauda*, *Helicosalpa komaii* and *Cyclosalpa strongylenteron*), Yount (1958) stated that the Salpidae are cosmopolitan oceanic organisms of the circum-global warm water zone. In a discussion of physico-chemical factors of the environment, Yount linked the occurrence of greater numbers of salps to high primary productivity in areas of upwelling and those regions possibly influenced by current shear or proximity to islands. No other relationships to ecological parameters could be determined from his data.

Records of thaliacean species in the Caribbean are so few that Björnberg (1971) named only *Doliolum nationalis* and *D. mülleri*, *Dolioletta gegenbauri* and the salp, *Thalia democratica*, which had been found by Zoppi (1961) in the region of the Cariaco Trench off Venezuela. The three species reported by Owre & Foyo (1972), *Salpa fusiformis*, *Thalia democratica* and *Weelia cylindrica*, were the salps most frequently collected in the Caribbean area. Their distributional records are contained in Tables 104-106. In addition, *Ihlea punctata* occurred at three widely separated stations, one in the Florida Straits (P 6904, Sta. 1, 38 m), one north of Panama (P 6811, Sta. 8, 27 m) and the third, south of Hispaniola (P 6911, Sta. 10, 56 m). This poorly known species, reported from Bermuda by Moore (1949) as *Salpa punctata*, appears to be a new record for the Caribbean and the Florida Straits.

TABLE 102

Relative abundance and vertical distribution of Salpidae collected inthe Caribbean Sea and adjacent areas.

Species	Depth Range (m)	Range (m) of Maximum Nos.	Number of Samples	Total Estimated Numbers Collected
Ihlea punctata	27-56	-	3	1,630
Salpa fusiformis	0-635	0-300	36	2,616
Thalia democratica	0-770	0-100	61	25,530
Weelia cylindrica	0- 75	0- 50	31	6,913

Data on abundance and vertical range are summarized in Table 102. By far the most numerous species, which Moore (1949) also found most abundant near Bermuda, was Thalia democratica (Fig. 44B). Apstein (1906) termed it the most common species of salp in warm water, an observation confirmed by later authors, including Yount (1958). T. democratica lives primarily in the Tropical Surface Water and the Subtropical Underwater, as do Weelia cylindrica (Fig. 45) and I. punctata, according to present records. The distribution of Salpa fusiformis (Fig. 44A) in relation to temperature and salinity was much more extensive; it was relatively abundant through the warm water sphere and the boundary layers, and into the Subantarctic Intermediate Water. This species has been reported by Yount (1958) and others as second or third in abundance to T. democratica. However, Ritter (1905) found it the more numerous of the two off California. Yount suggested that this might be "...a result of the lower temperatures in California waters," and our data show that S. fusiformis is eurythermal in comparison with T. democratica.

Except for heteropods, salps were the most infrequently collected of all the groups studied. Owing to the type of life history, in which forms

produced by budding of a solitary asexual generation and aggregated in chains, break free to reproduce sexually, giving rise to the solitary stage, distribution in the open sea is always patchy. This is illustrated by the relation between the number of samples and the abundance per sample shown in Table 103, which is a summary from Table 23, and in Figure 46. Like the siphonophores, salps were much more numerous in the Yucatan Channel, where massing occurs, the eastern Caribbean and the areas of upwelling than they were in the western and central portions.

TABLE 103

Data on horizontal distribution of salps summarized from Table 23.

Location	No. of Stations	Range in No. of Salps Collected	Avg. of Total No. Collected per Station
Yucatan Channel	4	0-1250	317
Western Caribbean	8	0- 800	175
Central Caribbean	6	30- 300	131
Eastern Caribbean	14	0-2120	739
Areas of upwelling	12	0-1000	275
Passages	4	0-100	44

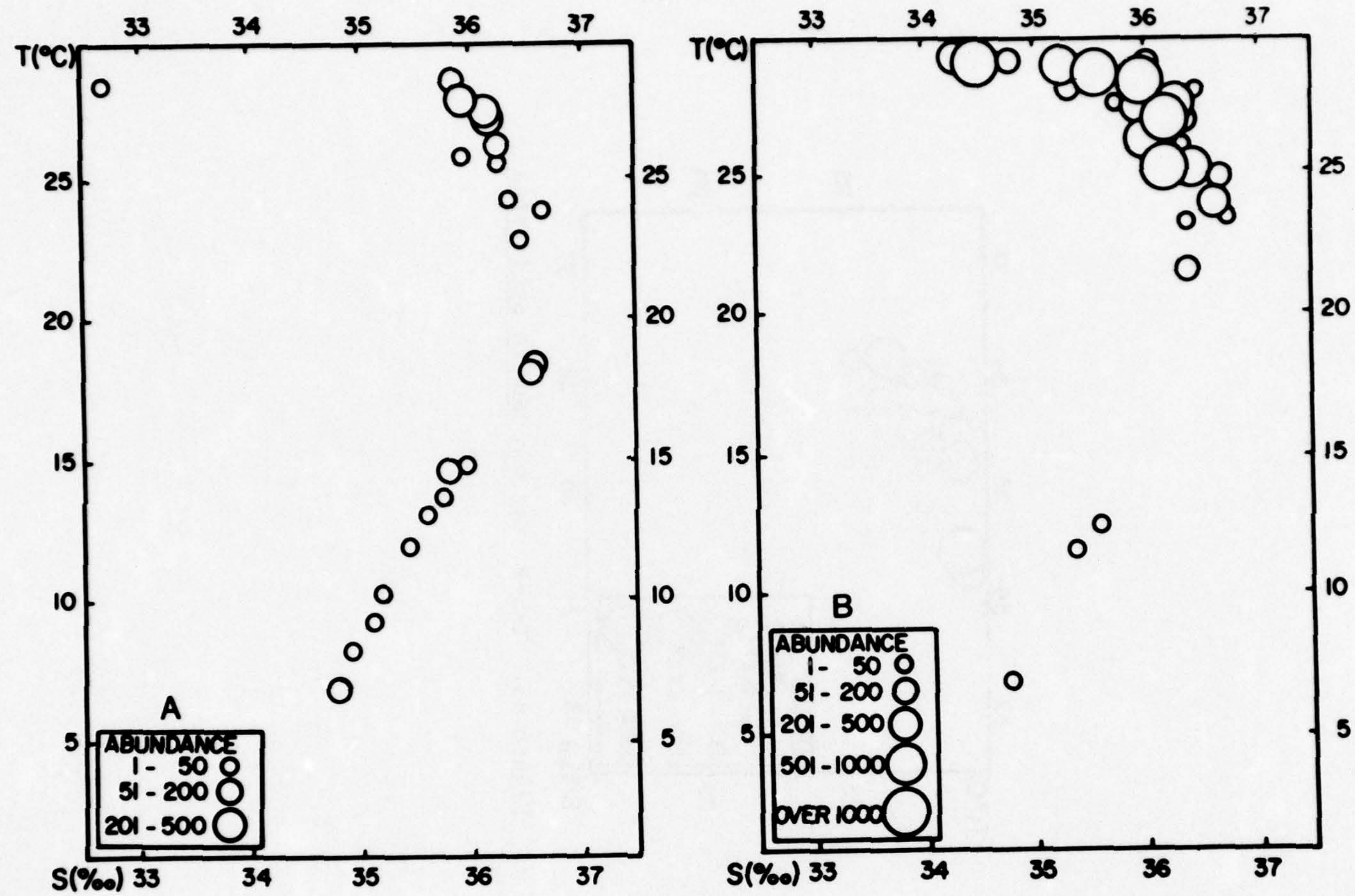

Figure 44. T-S-P diagrams, (A) *Salpa fusiformis* and (B) *Thalia democratica*

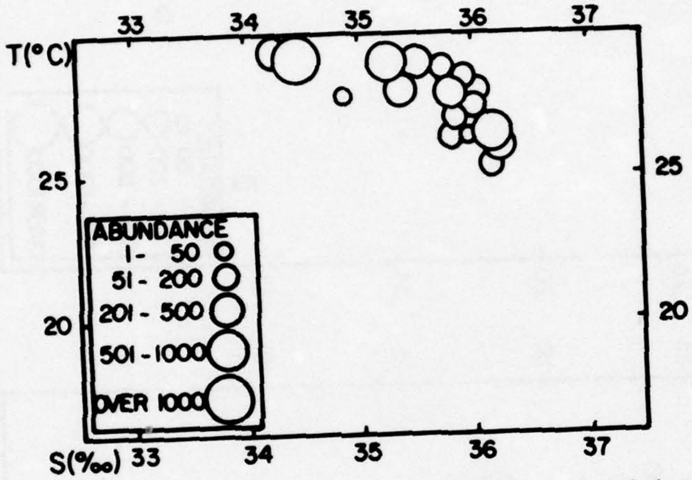

Figure 45. T-S-P diagram, Weelia cylindrica

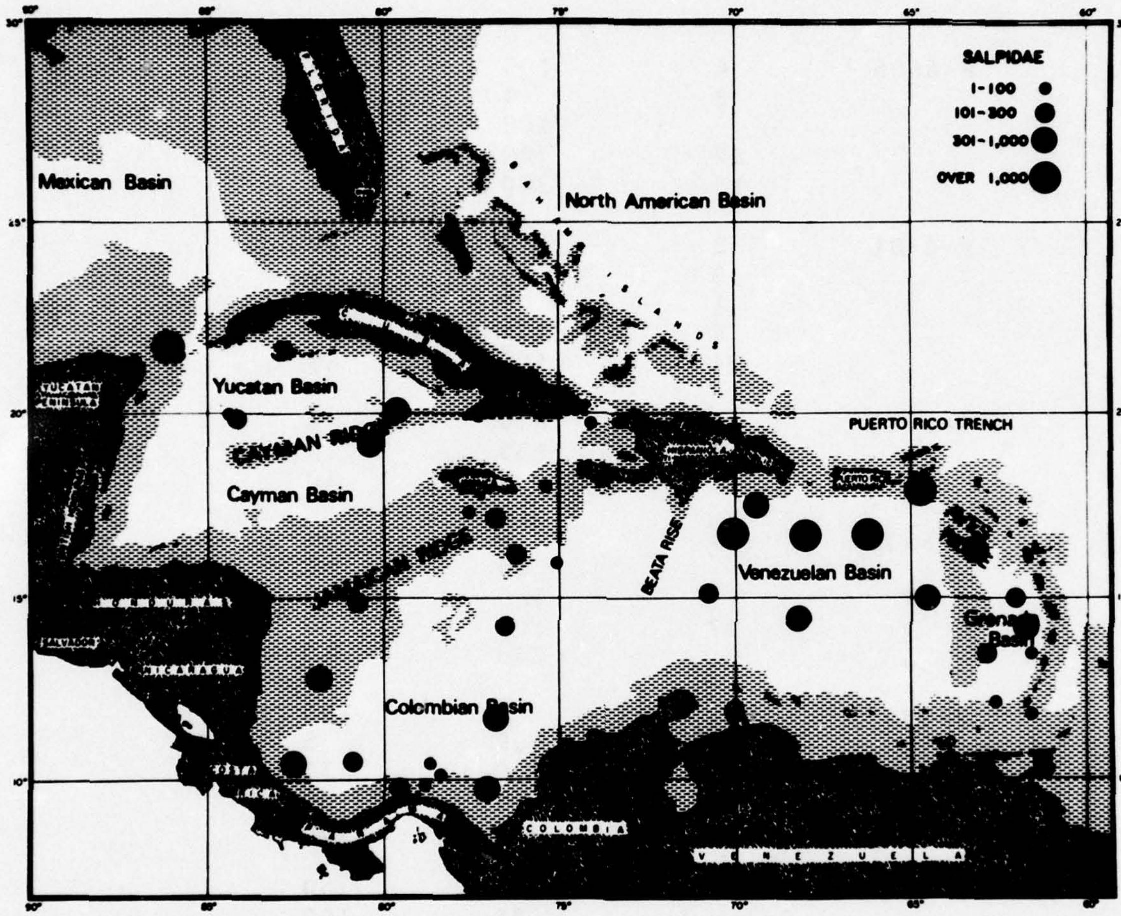

Figure 46. Total numbers of Salpidae collected at 48 stations selected to compare abundance in major Caribbean areas (see Table 23)

TABLE 104

Vertical distribution of *Salpa fusiformis*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	4	103	100
	8	0	400
		100	50
	12	300	25
	13	300	25
P-6701	2	500	20
	3	0	20
	4	0	15
	8	250	20
	24	500	40
G-6722	10	630	2
	15	635	4
	17	250	10
P-6803	4	0	20
		30	50
	11	580	120
	17	100	50
		240	10
P-6805	3	0	100
	7	500	5
	9	0	250
		65	50
	10	0	350
P-6811	5	250	150
	6	25	100
	9	450	5
	11	45	250
P-6904	16	253	80
	17	0	100
	18	261	60
	20	0	30
	21	0	25

TABLE 104 (continued)

Vertical distribution of Salpa fusiformis

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
	22	372	10
P-6911	5	59	30
	6	0	20
	8	510	20

TABLE 105

Vertical distribution of *Thalia democratica*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6701	8	0	50
	22	0	120
C-6722	9	40	50
P-6803	11	0	40
		30	100
	15	100	500
	16	100	240
	20	0	25
		75	100
P-6805	4	90	800
	7	0	50
P-6811	3	0	200
		770	4
	4	0	50
		50	100
	5	0	150
		25	150
	6	0	50
	9	0	50
	10	25	150
	11	0	100
		45	300
	12	35	200
	15	0	50
	18	0	150
P-6904	1	0	950
		38	11100
		415	10
	2	0	1150
		14	300
	3	30	4
	7	25	50
	9	0	45

TABLE 105 (continued)

Vertical distribution of *Thalia democratica*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
		70	60
	10	30	60
		455	10
	11	0	100
		45	100
	12	0	180
		30	50
	14	37	20
	15	52	50
	16	59	40
	18	0	90
		62	20
	20	0	50
		10	150
P-6911	1	65	800
	2	53	200
	3	60	150
	4	81	500
	6	50	100
	7	0	132
		60	180
	8	60	2000
	9	60	100
	10	56	1750
	11	58	550
	13	65	100
	14	34	400
	15	53	200

TABLE 106

Vertical distribution of *Weelia cylindrica*

CRUISE	STATION	DEPTH (m)	ESTIMATED NUMBER
P-6606	4	0	200
	14	10	150
P-6701	10	0	3
G-6722	15	0	60
P-6803	17	0	150
	20	75	40
P-6805	5	0	50
P-6811	1	0	100
	2	0	30
	5	25	550
	6	0	450
	8	27	10
	9	0	50
	10	0	350
	15	0	300
P-6904	1	0	50
		38	200
	2	14	100
	7	25	50
	12	30	350
	14	0	10
	20	0	40
		10	300
P-6911	1	0	750
	2	0	450
	4	0	120
	6	50	100
	8	60	100
	9	0	1450
		60	100
	13	0	250

DISCUSSION

The preceding observations on hydrography and the distribution of the 87 species studied as well as the three groups of additional calanoid, harpacticoid and cyclopoid species are intended as an introduction to Caribbean zooplankton. Limitations in time and personnel prevented an exhaustive analysis of any of the six groups of organisms discussed in Part I. However, all of the data are herewith made available for further analysis by interested specialists. In Part II, the thecosome molluscs, a group of mainly epipelagic carnivores which includes species that are indicators of certain water masses, are treated in detail by Donald Haagensen. The amphipods in the collections are also the subject of a separate study, the results of which should be published soon. In any case, the specimens have been sorted and will be available at the Rosenstiel School of Marine and Atmospheric Science for examination by specialists, as are all of the samples.

A biological field program of this latitudinal and vertical magnitude probably will not again be attempted in the Caribbean,nor should it be needed. The cost of ship time alone today would amount to $750,000. These are thus very valuable data from the monetary standpoint and also in quality because every effort has been made to insure accuracy and consistency in their collection and analysis. The primary objective of the program was the accumulation of basic information on composition, relative abundance and distribution of major zooplanktonic elements as a foundation for future investigations of particular regions and biological aspects which deserve closer study. As development of the many nations surrounding the Caribbean

Sea accelerates and scientists become increasingly concerned about the marine environment, a survey of this nature should provide useful background information for regional investigators. On the other hand, some biologists believe that the major aspects of open ocean pelagic biology have long been known. Critics of the biological survey, a method of appraisal which probably reached the zenith of scientific unpopularity about midway through our program, do not in practice acknowledge a need to know kinds, numbers and distribution of species on a broad basis before trying to solve ecological problems on a more intimate level. In the text, we have used our own data (Owre & Foyo, 1972) to defend the comprehensive view by showing how easily the wrong conclusions can be drawn from samples collected at widely separated locations, even in the relatively uniformly populated and supposedly impoverished tropical western Atlantic and the Caribbean. For example, we earlier thought that *Farranula gracilis* was a common epipelagic species, perhaps slightly more numerous than *F. carinata*, judging from collections made on P 6602 at Caribbean stations and off northeastern South America. Thus both species were selected for individual counting. Using the greater amount of material now available, we find that *F. gracilis* is actually relatively rare. It appears to be a reliable indicator of equatorial Atlantic waters, at least to the north and probably also to the south of the equator. A similar error may have been made by Ackefors & Zillioux (1975), who concluded in their preliminary, unpublished report on the biology of *Undinula vulgaris* and *Calanus minor* in the northern Caribbean and the Florida Current that, "*U. vulgaris* was the most important copepod and species sampled within the studied area." This is a conclusion not entirely to be anticipated on the basis of published information, although *U. vulgaris* has long been known as a common species of the tropics and sub-

tropics. To the north of Ackefors & Zillioux's study area, Grice & Hart (1962) reported that Clausocalanus furcatus was the most abundant calanoid in their samples from the Gulf Stream and the Sargasso Sea. Also, Bowman (1971), who analyzed the distribution of calanoids along the U.S. east coast between Cape Hatteras and south Florida at coastal, shelf and open ocean stations, including nine on the eastern edge of the Gulf Stream bordering the western Sargasso Sea, found that, "Undinula vulgaris and Calanus minor were among the most abundant and widespread of oceanic calanoids....", but he also stated that "Clausocalanus furcatus is one of the dominant species in the oceanic plankton." The data on U. vulgaris in Table 45 and the summary of relative abundance in Table 33 do not indicate that the species was unusually numerous over the broad area sampled. However, the sampling methods and regime of Ackefors & Zillioux were completely different from ours since they used a 1/2 m net with 64 μm mesh size for 10-15 min. tows in the upper 200 m at noon, sunset, midnight and sunrise. To compare the abundance in our collections of U. vulgaris with other common epipelagic forms at stations near some of those sampled by Ackefors & Zillioux, we used data from the upper 52 m (P 6904, Sta. 15) only, and we found that the numbers of other species usually exceeded those of U. vulgaris, and the counts of "other Calanoida" and "other Cyclopoida" were usually vastly greater (Table 107). It appears that the question of "importance" or dominance among copepods in the Caribbean area needs further investigation, with special reference to the occurrence of non-calanoids.

Aside from reporting the occurrence of species of the several animal groups, aspects of particular interest in our study have been the relative abundance of species within a group and also of groups, the horizontal and vertical distribution of this abundance, the associations of species in the

TABLE 107

A comparison of numbers of common epipelagic copepod species and groups caught in the upper 52 m at selected stations north and south of the Greater Antilles.

Station	U. vul-garis	C. furca-tus	M. rosea	F. car-inata	O. plumi-fera	other Calanoida	other Cyclopoida
P 6904, Sta. 15	-	3,080	360	2,420	2,950	11,590	4,320
16	28	18	1,528	34	6	16,200	102
17	120	150	410	460	140	5,470	1,290
18	40	20	30	90	10	225	105
19	-	310	1,960	5,320	2,280	24,220	5,770
20	-	2,010	2,420	10,330	1,100	49,370	6,270
21	1,860	4,270	165	355	2,610	14,620	6,325
22	-	2,300	950	1,420	6,350	12,488	5,410
P 6904 Sta. 12	1,040	155	956	153	379	3,051	1,052

open sea, and the value of certain species as indicators of water movements, including upwelling.

Horizontal and vertical distribution.-- Copepods are the most numerous groups of metazoan plankton in the Caribbean, and they are also the most widely distributed vertically of the animals studied. The predatory chaetognaths, which are far less abundant, rank next and are more restricted vertically (Tables 33 and 82). Euphausiids, which can be classified as plankton or micronekton, depending on size, and are major elements of the total biomass, were inadequately sampled by our nets. They were collected as deep as 2660 m (Table 60) but, as shown in Vinogradov's (1968) compendium and by Roger (1974), the maximum concentrations are found in the upper 500 m. Siphonophores and salps are primarily epipelagic forms in tropical seas. Although all of these kinds of organisms occur in groups of varying density in our samples, swarming was most noticeable in the collections of siphonophores and salps. Their life cycles include alternation of sexually and asexually reproducing forms, the latter budding the former. Their distribution is accordingly patchy. By far the greatest numbers of all these species are found in TSW and SUW, approximately the upper 200 m. Below this, zooplankton becomes comparatively sparse in individuals but not in numbers of species of copepods and chaetognaths. Often a secondary numerical maximum is found in the vicinity of 500 m, in the upper NACW, where mesopelagic species are common.

According to Kolesnikov (1968), biomass of zooplankton in the Gulf of Mexico and the western Caribbean Sea does not basically differ from that in the tropical Atlantic Ocean. This seems unlikely because there are numerous enriched shoal areas such as the banks north of the Jamaican Ridge and the Campeche Banks, but we have no data from the Atlantic for comparison. In the central and eastern parts, Moryakova (1968) reported finding homogeneous

plankton distribution, "...due to similar distribution of hydrological factors." We did not find a uniform horizontal distribution in abundance of any group, as shown in Figs. 14, 25, 26, 35, 43 and 46, which illustrate information found in Tables 23 and summarized in Table 108. The greatest numbers of organisms were collected in the central Caribbean and the areas of upwelling in the Central American bight. Owre & Foyo (1964) suggested that the eastern Caribbean may be a nursery for plankton because of the high proportion of immature copepods collected at two stations there. Reproduction in the relatively quiet waters of the eastern areas may indeed account for the very large numbers collected at stations in the central and southern Caribbean. The turbulence and swift movement of waters which often characterize the passages would not appear conducive to the development of large populations in those areas, and far lower numbers were collected there and in the Yucatan Channel. The western Caribbean is also comparatively rich but less so than the central region, perhaps because of predation on the zooplankton as well as natural mortality as the animals are slowly moved northwestward by the Caribbean Current.

Association of species. -- Several studies of species associations or groupings within the copepods, euphausiids and chaetognaths in areas near or similar to the Caribbean and Florida Straits have been made. Among them are Bowman's (1971) work on calanoid copepods off the southeastern United States, Roger's (1974) work on euphausiids in the equatorial and south tropical Pacific, based on large numbers of specimens, and Stone's (1969) on the chaetognaths of the Agulhas Current in the southwest Indian Ocean. Much of this information probably also applies to groupings in the Caribbean, although our data on euphausiids are insufficient for comparison because of inadequate sampling of these organisms.

TABLE 108

Data on horizontal distribution of siphonophores, copepods, euphausiids, chaetognaths and salps summarized from Table 23.

Location	No. of Stations	Range in Total Nos. Collected	Average of Total No. Collected per Station
Yucatan Channel	4	43, 222-121, 386	69,766
Western Caribbean	8	43, 187-191, 511	84,271
Central Caribbean	6	49, 053-203, 460	103,605
Eastern Caribbean	14	20, 938-115, 168	63,335
Areas of Upwelling	12	30, 463-186, 546	97,336
Passages	4	8, 987-92, 930	53,607

Using the affinity index of Fager & McGowan (1963), Bowman (1971) analyzed the associations of 13 species of calanoid copepods which consistently occurred in the upper 70 m in coastal and shelf waters and in the Gulf Stream between Cape Hatteras and south Florida. Seven of the 13 comprised the oceanic association: *Calanus minor*, *Temora stylifera*, *Clausocalanus furcatus*, *Euchaeta marina*, *Lucicutia flavicornis*, *Paracalanus aculeatus* and *Undinula vulgaris*. The last five were the most common epipelagic forms among the calanoid species counted in our project. Bowman found that the seven "...form a rather tightly knit group, with the exception of *Lucicutia flavicornis*, which has the lowest association with the other species of any member of the oceanic association." Possibly *L. flavicornis* was aggregated below 70 m at the time that some of Bowman's samples were collected. As discussed

earlier, maximum numbers of this species in the Caribbean are spread over a greater vertical range than those of the other common epipelagic species and it also avoids surface waters in the daytime (Fig. 17A, Table 39).

Stone (1969) made a series of analyses of chaetognaths collected from the upper 400 m in the Agulhas Current and in coastal waters of the area with three kinds of nets, each differently fished. The fauna included the cosmopolitan oceanic species also found in the Caribbean: *Krohnitta pacifica*, *K. subtilis*, *Pterosagitta draco*, *Sagitta bipunctata*, *S. decipiens*, *S. enflata*, *S. hexaptera*, *S. lyra*, *S. minima* and *S. serratodentata*. Stone found no species of *Eukrohnia* except *E. hamata*. It and *S. planctonis* were among the "very rare" species for which he found no affinities. In the Caribbean, too, *E. hamata* and *S. planctonis* were among the five rarely collected species (Table 81). Oceanic forms not reported by Stone, perhaps because they ordinarily are found below the range he sampled, are *S. zetesios* and *S. macrocephala*, in addition to the three species of *Eukrohnia* (Table 82). However, in the Caribbean, *S. zetesios*, though collected only 27 times (Table 101) does occur with three mesopelagic species reported by Stone, *Krohnitta subtilis*, *Sagitta decipiens* and *S. lyra*. It also occurred in the company of the deeper-living *Eukrohnia bathyantarctica*, *E. bathypelagica*, *E. fowleri*, and *S. macrocephala* (Table 109). The distribution of *S. zetesios* in regard to that of other species will be discussed later.

Stone's analysis showed us little that we did not already know about the groupings of tropical and temperate chaetognath fauna from studies of waters off the southeastern United States, including the Florida Current (Owre, 1960; Pierce, 1953, 1958; Pierce & Wass, 1962). He found that *Sagitta enflata*, *S. serratodentata*, *Pterosagitta draco*, *S. hexaptera* and

TABLE 109

Species with which *Sagitta zetesios* was collected in the Caribbean Sea and adjacent areas, arranged in order of depth of collection.

Station	Depth (m)	*K. subtilis*	*S. lyra*	*S. decipiens*	*E. bathypelagica*	*E. bathyantarctica*	*E. fowleri*	*S. macrocephala*
P6811, 1	38	-	-	-	-	-	-	-
6911, 12	153	-	+	+	-	-	-	-
6805, 4	250	+	+	+	-	-	-	-
6911, 17	261	+	+	+	-	-	-	-
6811, 12	290	+	+	+	-	-	-	-
6911, 4	423	+	+	+	+	-	-	-
12	465	+	+	+	-	-	-	-
6805, 10	477	-	+	+	-	+	-	-
6911, 10	480	+	+	+	+	-	-	-
11	491	+	+	+	+	-	-	-
3	494	-	+	-	+	-	-	-
6811, 5	500	-	+	+	+	-	-	-
7	500	-	+	-	+	-	-	-
10	500	-	+	-	+	-	-	-
6911, 13	500	+	+	+	-	-	-	-
6811, 2	508	-	+	+	+	-	-	-
6911, 8	510	-	+	+	+	-	-	-
17	514	+	+	+	-	-	-	-
6805, 11	537	-	+	+	-	+	-	-
6811, 4	550	-	+	+	+	+	-	-
16	750	-	-	-	+	+	+	+
11	800	-	-	-	+	-	+	+
6911, 1	911	-	-	-	-	-	+	+
6805, 10	995	-	-	-	-	-	+	+
11	1050	-	-	-	-	+	+	+
6811, 4	1050	-	+	-	+	-	-	+
	3000	-	+	-	-	-	-	+

S. bipunctata were common to all of his types of sampling, and that *S. decipiens*, *S. lyra* and *K. subtilis* did not have affinities with any species, "...which would be expected on the basis of their vertical distribution...." Similarly, Bowman's (1971) calculations of associations, diversity and dominance diversity or equatibility only reinforced old knowledge with new data. That various species may or may not be frequently caught together and thus may or may not be associated is well known today and is useful in identifying water masses. However, the knowledge puts us little closer to understanding the biological reasons for the presence of oceanic species at particular depths in certain areas than we were when investigators battled over which was the stronger factor influencing vertical distribution, temperature or light. Although Fager (1957) made it clear that he was using the concept of affinity in the sense that species which rather often form mixed populations have a strong affinity in contrast to those which never do and thus have no affinity, the term "affinity index" continues to imply, by definition, more information than it can offer. The calculations in no way reveal "causal connection or relationship" or "a relation between species or higher groups dependent on resemblance in the whole plan of structure and indicating community of origin" as affinity is defined in Webster's Third New International Dictionary of the English Language, Unabridged, 1966. Bowman was sufficiently wary to write, "A number of theories have been proposed to explain the sort of dominance diversity found in the *Gill* samples. Most of these are highly mathematical and are based on simplified assumptions that are not yet fully proved. New and revised theories appear at a greater rate than the observations and experiments needed to supply a firm factual basis for them." We made only limited use of this technique in analyzing

the Caribbean data.

Affinity indices were calculated from data on all species collected on P 6911 over the entire vertical range and also for the upper 100 m alone. Since we were dealing with widely different kinds of animals of many species, distributed over depths of thousands of meters, it is not surprising that groupings appeared only at low levels (0.030-0.50). These are listed in Table 110. Predominantly epipelagic species of siphonophores, copepods and chaetognaths, with one euphausiid and one salpid affinity, form the groups with indices of 0.30 and 0.33. At an index of 0.50 of species collected at all depths sampled, there were two groups, one epipelagic and the other clearly bathypelagic, but the mesopelagic species did not emerge as a group in the program. Using only the data from the upper 100 m on P 6911, one finds the following five species with an affinity index of 0.50: Sagitta enflata, Clausocalanus furcatus, Paracalanus aculeatus, Oithona plumifera and Microsetella rosea. The relative abundance of non-calanoid copepods compared with calanoids shown in Table 33, and their probable importance in open ocean ecology, are reflected in their prominence in the lists of associated species.

One of the more interesting aspects of the analyses is the deep-water grouping, although the existence of it as well as the shallower groupings is readily evident in the raw data. There seem to be few questions regarding the groups and vertical distribution of either the mainly shallow-living or the mainly bathypelagic species, whereas many species are found in habitats, which might be termed ecotonal in other areas, located between the two and not shown in the recurrent groups analysis. Among the chaetognaths, the mesopelagic Sagitta zetesios and associated species are examples.

TABLE 110

Recurrent groups of species collected from all levels on P 6911.

Affinity index 0.30*	Affinity index 0.33**	Affinity index 0.50
Microsetella rosea	Microsetella rosea	Group A. Sagitta serratodentata
Macrosetella gracilis	Diphyes bojani	S. enflata
Sagitta enflata	Macrosetella gracilis	Paracalanus aculeatus
S. serratodentata	Sagitta enflata	Clausocalanus furcatus
Paracalanus aculeatus	S. serratodentata	Krohnitta pacifica
Oncaea venusta	Paracalanus aculeatus	Diphyes bojani
Diphyes bojani	Clausocalanus furcatus	Acrocalanus longicornis
Clausocalanus furcatus	Krohnitta pacifica	Farranula carinata
Krohnitta pacifica	Oncaea venusta	These have affinity only with preceding group:
Acrocalanus longicornis	Acrocalanus longicornis	Abylopsis eschscholtzii Undinula vulgaris S. hispida Euchaeta marina
Farranula carinata	Farranula carinata	
S. hexaptera	S. hexaptera	Group B. Mormonilla minor
Abylopsis tetragona	Pterosagitta draco	
Scolecithrix danae	Euchaeta marina	Rhincalanus cornutus
Pterosagitta draco	Scolecithrix danae	M. phasma
Euchaeta marina	Oithona plumifera	Conaea gracilis
Oithona plumifera		S. macrocephala
		Aegisthus aculeatus
		These have affinity only with preceding group: Eukrohnia fowleri E. bathypelagica

*Euphausia tenera has affinity only with this group.

**Weelia cylindrica has affinity only with this group.

though rare in the collections and caught only 27 times, S. zetesios spanned epipelagic, mesopelagic and bathypelagic realms in the Caribbean and adjacent areas (Tables 82 and 83). The depths at which it was collected and the species usually found with it in samples are listed in Table 109. In the shallowest collection, it was the atypical species in the regular epipelagic assemblage of Sagitta bipunctata, S. enflata, S. serratodentata, Krohnitta pacifica and Pterosagitta draco. At greater depths, down to 550 m, it occurred primarily with K. subtilis, S. lyra and S. decipiens, with Eukrohnia bathypelagica appearing in catches below 400 m. In those below 550 m, the first three species were essentially replaced by the three species of Eukrohnia and S. macrocephala.

Indicator species. -- Aside from the thecosomes discussed in Part II, copepods and chaetognaths are the best known sources of species which can serve as indicators of certain water masses. Both are characterized by distinctive latitudinal and vertical species groupings. As Bowman (1971) pointed out, an association of calanoid copepod species can be a reliable indicator of the presence of coastal, shelf and oceanic waters in a given area. In the Caribbean, the relative abundance of harpacticoid and cyclopoid elements of the copepod fauna in coastal areas needs investigating, the combinations of common oceanic species being relatively well known. Group A in Table 110 is typical of TSW and SUW in the Caribbean. Also, the distribution of the cyclopoid, Farranula gracilis, in warm, saline waters centered in the equatorial regions indicates that it is a label of water of shallow equatorial origin through the Caribbean and into the Florida Straits. These indicators are all relatively limited in their vertical distribution. On the other hand, Group B contains some forms, such as Mormonilla minor

and Rhincalanus cornutus, with such extensive vertical ranges that they are not useful indicators. The distribution of deep-living copepod species is not well enough known at this time for the recognition of reliable indicators, with few exceptions. One is Aegisthus aculeatus (Fig. 20B) which lives primarily in SAIW and NADW and, when found at lesser depths, can mark upwelling of these waters (e.g., P 6811, Sta. 9).

Among the Chaetognatha, epipelagic species known to occur in the Caribbean which are characteristic of coastal waters and thus mark its presence when found in the open sea are Sagitta friderici, S. helenae, S. hispida and S. tenuis. Shallow oceanic waters support populations of the cosmopolitan species S. bipunctata, S. enflata, S. hexaptera, S. serratodentata, Krohnitta pacifica and Pterosagitta draco. The deep-water species are the most restricted in their distribution (e.g., Figs. 42A, B, C, D) and thus serve to indicate upwelling, as S. lyra, S. macrocephala and E. bathyantarctica did at P 6811, Sta. 9 (Table 7). Remarks on upwelling in the Caribbean and its effects on the distribution of some planktonic forms are located in the discussion of the section on physical and chemical data, in the introduction to the section on Copepoda, and in the discussion of the section on Chaetognatha.

The possibility that oceanic species rare in the Caribbean may be indicators of waters entering the area from the North Atlantic was a subject for speculation in the section on Chaetognatha. Eukrohnia hamata and Sagitta planctonis are known to be established in the North Atlantic and E. proboscidea and S. megalopthalma are assumed to be, as there must be a population in the general area from which the strays found in the Caribbean were derived (Table 81). The locations at which the specimens were collected

are, in many cases, in or near the Windward and Anegada Passages and those between the Lesser Antilles. Frequent sampling in one or more of these areas might well show that there are biological labels to mark the influx of North Atlantic waters at various depths.

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Part II.

Thecosomata.

D. A. Haagensen

PART II

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INTRODUCTION

Thecosomata are holoplanktonic opisthobranch mollusks that are widespread and abundant in all the world's major oceans. They live predominantly in warm epipelagic regions but also occur in deeper waters and in temperate and polar seas. Historically, the Thecosomata have been combined with another holoplanktonic opisthobranch group, the Gymnosomata, in the Order Pteropoda. As early as 1886, however, Boas indicated that the two groups should not be considered one systematic unit. Supporting studies by Pelseneer (1887, 1888b), Meisenheimer (1905) and Morton (1954a) showed that the two groups have little more in common than a pelagic environment and the same means of locomotion, namely, parapodia modified into swimming wings. Although Thiele (1931) and Hoffman (1938) retained the Order Pteropoda, the term "pteropods" is most often used today in the vernacular sense. The presently accepted system of classification is:

Class Gastropoda
  Subclass Opisthobranchia
    Order Thecosomata
      Suborder Euthecosomata
        Family Limacinidae
          Genus Limacina
        Family Cavoliniidae
          Genera Creseis, Styliola, Hyalocylis, Clio, Cuvierina, Diacria, Cavolinia
      Suborder Pseudothecosomata
        Family Peracliidae
          Genus Peraclis

Family Cymbuliidae

Genera _Cymbulia_, _Corolla_, _Gleba_

Family Desmopteridae

Genus _Desmopterus_

Order Gymnosomata

At the specific and infraspecific levels the taxonomy of the thecosomes has been problematical. Like the majority of the shelled Mollusca, specific and subspecific names have been introduced for even the smallest of individual shell variations. Thus, intricate synonymies have developed for most species. Pelseneer (1888b), in the first monographic work on the group, did much to resolve their taxonomy, and his study has proved to be a landmark for all later workers.

Recently, with the use of thecosomes as indicators of water masses, attention has again been focused on infraspecific levels. As Spoel (1971b) has pointed out, subspecies are generally limited in their distributions by provinces in the ocean and infrasubspecific forms by particular water masses. This makes infraspecific identifications a valuable tool for characterizing water masses and current patterns. Because of the importance of infraspecific levels of classification in characterizing water masses and current patterns, I have identified all species whenever possible to subspecific and infrasubspecific levels. Spoel (1967, 1969a, 1971b) has introduced the term "forma" to designate infrasubspecific forms. This is an appropriate term and I shall follow Spoel's usage of it.

No thorough zoogeographic analysis of the Thecosomata of the Caribbean Sea has ever been made. Many of the large-scale oceanographic expeditions of the late 1800's and early 1900's collected zooplankton in

the tropical Atlantic as part of their surveys. Thecosomes in these samples were later studied by Pelseneer (1888a, b) for the CHALLENGER, Schiemenz (1906) for the North Atlantic Plankton Expedition, Meisenheimer (1905) for the VALDIVIA, Massy (1920) for the TERRA NOVA, Tesch (1946) for the DANA, and Spoel (1970a) for the ATLANTIDE and GALATHEA. Only the DANA, however, occupied extensive stations in the Caribbean and most of these were restricted to the area around Puerto Rico and St. Croix. In addition to the DANA collections, there have been several small-scale, near-shore studies in the Caribbean (Cervigón and Marcano, 1965; Lewis and Fish, 1969; Wells, 1973). Table I contains a summary of previous work in the area. In order to consider only water directly involved with the Caribbean, records from the North Equatorial Current are restricted to those west of 20°W and south of 20°N, and those from the Florida Current are limited to that portion south of 27°N.

All of these studies have dealt with systematics, morphology, or local patterns of distribution. On a world-wide basis these same aspects--systematics, morphology and distribution--have been well studied; but information concerning the biology of thecosomes is lacking. In recent years studies dealing with the use of thecosomes as "indicators" of water conditions have provided information on their relationships to water masses and current patterns (Hida, 1957; McGowan, 1960; Chen and Bé, 1964; Myers, 1968; Chen and Hillman, 1970; Boltovskoy, 1971; Austin, 1971). All of these works, however, with the exception of Myers (1968) and Austin (1971), were quite limited in application, being based on capture of thecosomes from vertical or oblique tows instead of discrete depth levels and using previously published hydrographic data or surface observations rather than quasi-synoptically collected data from all levels of capture. The methodology of discrete depth sampling

TABLE 1

List of Thecosomata Collected from the North Equatorial Current, Caribbean Sea, and Gulf of Mexico and Florida Current.

Species	N. Eq.Cur.[1]	Caribbean Present Study	Caribbean Historical[2]	G. Mex. & Fl. C.[3]
L. retroversa				X
L. inflata	X	X	X	X
L. helicoides	X			X[4]
L. lesueurii	X	X	X	X
L. trochiformis	X	X	X	X
L. bulimoides	X	X	X	X
Cr. acicula	X	X	X	X
Cr. a. f. acicula	X	X		X
Cr. a. f. clava	X			X
Cr. virgula	X	X	X	X
Cr. v. f. virgula	X	X	X	X
Cr. v. f. conica	X	X	X	X
S. subula	X	X	X	X
H. striata	X	X	X	X
Cl. pyramidata	X	X	X	X
Cl. p. f. lanceolata	X	X		
Cl. p. f. martensii			X[5]	
Cl. cuspidata	X	X		X
Cl. chaptalii	X		X	X
Cl. polita	X	X	X	X
Cl. recurva	X		X	X
Cl. andreae	X			
Cuv. columnella	X	X	X	X
Cuv. c. f. atlantica		X		
D. trispinosa	X	X	X	X
D. t. f. trispinosa	X	X		X
D. t. f. major	X	X		X
D. quadridentata	X	X	X	X
D. q. f. quadridentata	X			
D. q. f. costata	X			
D. q. f. danae		X		

Species	N. Eq. Cur.[1]	Caribbean Present Study	Caribbean Historical[2]	G. Mex. & Fl. C.[3]
Cav. longirostris	X	X	X	X
Cav. l. f. longirostris	X	X		
Cav. l. f. limbata	X	X		
Cav. l. f. strangulata	X	X		
Cav. tridentata	X		X	X
Cav. t. f. tridentata	X			
Cav. uncinata	X	X	X	X
Cav. u. f. uncinata	X	X		
Cav. gibbosa	X	X	X	X
Cav. g. f. flava	X			
Cav. globulosa	X			
Cav. inflexa	X	X	X	X
Cav. i. f. inflexa	X	X		X
Cav. i. f. labiata	X			
P. reticulata	X	X	X	X
P. bispinosa	X	X	X	X
P. moluccensis	X	X	X	X
P. triacantha		X	X	X
P. apicifulva	X	X	X	X
P. depressa	X			
Cym. sp.	X	X	X	X
Cym. peroni	X			X
Cym. sibogae	X			
Cym. parvidentata				
Gl. sp.	X	X		X
Gl. cordata	X	X		X
Cor. sp.	X	X	X	X[6]
Cor. spectabilis	X			X
Cor. calceola	X			X
Des. papilio	X	X	X	X
Des. gardineri		X		X

[1]North Equatorial Current References: Pfeffer, 1880; Boas, 1886; Munthe, 1887; Pelseneer, 1888a; Peck, 1893; Meisenheimer, 1906b; Schiemenz, 1906; Vayssière, 1915; Tesch, 1946; Spoel, 1962, 1969b, 1970 a and b.

[2]Caribbean References: Pfeffer, 1880; Boas, 1886; Dautzenberg, 1900; Dall, 1901; Issel, 1913; Tesch, 1946; Suarez-Caabro, 1959; Nowell-Usticke, 1959; Legaré, 1961; Zoppi, 1961; Cervigon and Marcano, 1965; Lewis and Fish, 1969; Troost and Spoel, 1972; Lalli and Wells, 1973; Wells, 1973 and 1974.

[3]Gulf of Mexico and Florida Current References: Boas, 1886; Dall, 1889; Tesch, 1907 and 1946; Burkenroad, 1933; Reed, 1941; Moore et al., 1953; Parker, 1956 and 1960; Kornicker, 1959; Hutton, 1960; Wormelle, 1962; Merrill, 1963; Hopkins, 1966; Rodriguez, 1965; Hughes, 1968; Austin, 1971; Gilmer, 1972; Williams, 1972.

[4]Based on one specimen collected by Hughes (1968) in the Gulf of Mexico. No other specimens have ever been collected from the western Atlantic.

[5]Based on specimens collected by Pfeffer (1880) in the "Antillen."

[6]Wormelle (1962) collected one specimen which she identified as Desmopterus intermedia Tesch which probably was Corolla intermedia (Tesch, 1903).

and quasi-synoptic hydrographic observations is an absolute requirement in identifying a thecosome's physical-chemical environment and studying its relationships to that environment.

In the present study, material from the most extensive planktonic collections ever taken in the Caribbean Sea was used. All samples were collected from discrete depths and were supported by quasi-synoptic hydrographic observations. The observed horizontal and vertical population characteristics provide a definitive zoogeographic analysis of the Thecosomata of the entire Caribbean Sea.

Information on the relationships of Thecosomata to temperature, salinity, depth and geographic location are provided through analysis of each species and its environmental data, and the optimum and extreme ranges of salinity and temperature are delineated. Areas of high production are discussed in light of the water circulation of the Caribbean Sea. Differences in bathymetric distributions between day and night collections are discussed in relation to possible vertical migrations. Distributions are correlated with water masses, and the use of particular species as indicators of water masses is considered.

I am deeply grateful to Dr. Harding B. Michel, chairman of my thesis committee, for suggesting the study, providing materials and laboratory space, and supervising my research (Haagensen, 1975). The specimens on which the study was based were part of collections made under the auspices of the National Science Foundation (Grants GB-3808, GB-5776, GB-7082, GA-4569, GB-5625 and GB-13113). Preparation of the manuscript was supported by the Office of Naval Research (Contract N 00014-67-A-Z01-0013).

METHODS AND MATERIALS

The samples of zooplankton used in this study were collected in the Caribbean Sea and adjacent waters from the University of Miami's R/V JOHN ELLIOTT PILLSBURY and R/V GERDA during the period 1966 through 1969. General aspects of the collection program, including methods of collection and cruise tracklines, are presented and discussed in Owre and Low (1969), Owre and Foyo (1971, 1972) and in Part I of this work.

Due to the large quantities of material available (1188 individual samples from 177 stations), only selected stations were analyzed for Thecosomata. The selection of stations was limited to those having a complete vertical series of collections or at most missing only one level. From a total of 129 complete stations, 49 were selected to provide a broad comprehensive coverage of the entire Caribbean Sea with inclusion of important areas of exchange such as the Yucatan Channel, Windward Passage, Mona Passage, and the passages of the Lesser Antilles (Figure 1). Station data and related physical data for these stations are given in Part I.

Using a Wild M5 binocular microscope, all thecosomes in samples collected deeper than the thermocline were identified and counted. Samples collected from the thermocline to the surface were subsampled and all specimens in a 10 percent aliquot were identified and counted. All species in the remaining 90 percent of each sample were identified and enumerated except very abundant small juvenile specimens (usually over 100 individuals of the same species) of <u>Limacina</u>, <u>Creseis</u>, <u>Styliola</u>, and <u>Cavolinia</u>.

Upon examination of the samples, it was discovered that the majority of the shells had undergone partial or complete dissolution. A spot check of several samples indicated that they were all acidic with pH

values ranging from 5.0 to 6.5. Dissolution of shells through action of the preservative has presented problems to many workers (Tesch, 1946; McGowan, 1960; Myers, 1968; Spoel, 1972) since most taxonomically useful characters at the species level and all at the forma level are based on shell morphology. To facilitate identifications and also to provide material for illustrative purposes, fresh thecosomes were collected on cruises in September, 1972 and October, 1973. Using this material, determinations could be made by comparing identified specimens removed from shells with unidentified shell-less ones. A key to shelled and shell-less species of the North Atlantic prepared by Spoel (1972) was an additional aid in the identification of shell-less specimens. In the final analysis it was possible to identify most of the shell-less specimens, except for the smallest juveniles, to species but only the most obvious individuals of <u>Creseis</u> <u>acicula</u> forma <u>acicula</u>, <u>C</u>. <u>virgula</u> f. <u>virgula</u> and <u>C</u>. <u>virgula</u> f. <u>conica</u> could be identified with certainty to forma.

For the majority of the species identified in the Caribbean material, only one forma was found. Due to the poor knowledge of worldwide distribution at the forma level (Spoel, 1967), however, shell-less specimens of those species that could not be identified to forma were left at the species level.

One other area concerning identifications that was somewhat problematical involved juveniles. The literature contains many illustrations and descriptions of most species as adults, but very little information and few illustrations are available for the identification of juveniles. This lack of information is partly a result of the mesh size and the efficiency of the nets used by previous investigators. Up to the late

1960's all workers customarily used plankton nets with mesh sizes larger than 200 microns for the collection of Thecosomata. Wells (1973), however, demonstrated the inadequacy of using nets with such large mesh sizes. Comparing the efficiency of nets with 569 micron, 239 micron and 76 micron mesh openings, he found that as the aperture of the mesh decreased, the number of individuals captured increased. He also found that 55.2% of the individuals collected by the net with a mesh size of 76 microns, were within a size range of 100 to 200 microns and that 76.5% of the individuals were 300 microns or smaller. Wells' observations are reinforced by the fact that the few thecosomes observed through parts of their life cycles, either hatch or are released from the adult as free-swimming veligers with maximum diameters of slightly less than 100 microns (Lebour, 1932; Spoel, 1967; Paranjape, 1968; Lalli and Wells, 1973).

As an aid for the identification of juveniles, photographs and descriptive material are included in the section on systematics, distribution, and abundance.

A compilation of all thecosomes used in this study, listing by species and forma the numbers of adults and juveniles collected and their depths of collection and relative abundance, is found in Haagensen's (1975) M.S. Thesis. The differentiation between adult and juvenile individuals was based on size ranges as determined from historical data. Also, Spoel (1967) has shown that certain species of the Cavoliniidae undergo an irregular development and pass through immature "minute" or "skinny" stages immediately prior to reaching maturity, the shell being grown or nearly full grown while the body is half or less full size and incompletely developed. Included as juveniles were these "skinny" and

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"minute" forms as well as all veligers. Since no data on size at maturity of pseudothecosomes were available, only total numbers of individuals of each species were used.

To analyze the horizontal distribution of each species, the total numbers collected at a station were plotted on a map of the Caribbean, using circles of seven sizes to represent ranges in abundance. Because juvenile euthecosomes were far more numerous than adults and all pseudothecosomes, the intervals 1-32, 33-100, 101-320, 321-1000, 1001-3200, 3201-10000 and over 10000 represent the distribution of juvenile euthecosomes, and 1-3, 4-10, 11-32, 33-100, 101-320 and over 320, the others. Using the total numbers collected at a station eliminates the effect of vertical migration on the data, and ranges of abundance tend to nullify the inherent errors arising from patchiness, net avoidance and subsampling procedures.

In studies of bathymetric distribution, the 49 stations were separated into day (0800-1600 h), night (2000-0400 h) and twilight groups. The day and night stations were analyzed to determine which species exhibited diurnal migration, and only these were used to determine bathymetric distributional patterns of migrating species. Data from all stations were used to analyze the distribution of species showing little or no migration.

Temperature-salinity-plankton (T-S-P) diagrams were prepared to examine the relationships between the species and the environment and the possible use of each as an indicator organism. The T-S-P diagram has proved to be a valuable tool for numerous investigators (Bary, 1959, 1963, 1964; Bradshaw, 1959; Brinton, 1962; Johnson & Brinton, 1962; Bowman & McCain, 1967; Myers, 1968; Austin, 1971, 1972). In constructing

the diagram, the number of each species in a sample was plotted on a T/S diagram at the intersection of the values of temperature and salinity that had been quasi-synoptically determined for the sample. The numerical intervals are the same as those used in studying horizontal distribution. Although temperature and salinity influence the distribution of most planktonic organisms, they do not exert a direct, primary effect on the abundance of oceanic species. The value of the T-S-P diagram stems from the routine use of temperature and salinity as standard parameters characterizing water masses. Thus, in addition to illustrating the ranges of temperature, salinity and depth of a species, the diagram shows any association with a particular water mass which may exist.

SYSTEMATICS, DISTRIBUTION AND ABUNDANCE

In this section the data are analyzed separately for each species. Total and relative abundances, horizontal and vertical distribution, and optimum and extreme ranges of temperature and salinity are presented and compared to historical data. Emphasis for the historical data is on the Caribbean area specifically and tropical and subtropical Atlantic generally except where little information is available and a worldwide analysis is necessitated. Descriptions of adult species, illustrations and keys are so numerous in the literature, it would be pointless to duplicate efforts of others here. Most juveniles, however, have been mentioned only occasionally so comments concerning juvenile identifications are included.

Certain terminology involved in discussions of vertical distribution requires definition. Moore (1949) and Wormelle (1962) defined mean day level as the depth above which 50% of the individuals were collected during the daytime. Average day depth (level), as used in the present study, has the same meaning.

Genus *Limacina** Bosc, 1817

Limacina inflata (d'Orbigny, 1836)

Figures 2-5

Limacina inflata is a cosmopolitan, predominantly tropical and

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***Limacina* and *Spiratella* Blainville, 1817 were both published in December 1817 as generic names for this group (Spoel, 1972 and personal communication). Priority between the two has yet to be established. *Limacina* is used here because of its more frequent occurrence in scientific literature.

subtropical species. In many areas of the Atlantic it has been cited as the most abundant thecosome species. For example, it was first in abundance in the North Atlantic off the Grand Banks (Chen, 1962; Chen and Bé, 1964); in the Sargasso Sea (Tesch, 1946; Moore, 1949; Chen, 1962; Chen and Bé, 1964; Myers, 1968; Chen and Hillman, 1970); in the Florida Current (Wormelle, 1962); in parts of the Gulf of Mexico (Hughes, 1968; Austin, 1971) and in the southeastern Caribbean (Wells, 1973 and 1974). In general, however, because of the extremely small size of its veligers and juveniles (0.066 to 1.0 mm greatest diameter), L. inflata's true abundance has been underestimated through the use of the large mesh sizes (greater than 200 microns) traditionally used for planktonic collections. The only studies that could have approximated a representative collection of the total size range of individuals were those of Wells (1973 and 1974) and Lalli and Wells (1973), who used a finest mesh size of 76 microns, and the present study, in which the finest mesh size was 100 microns.

In Wells' 1973 work L. inflata was captured off Barbados at an average density of 1066.4 individuals per 1000 m^3 of water during the month of July. This density was 60.3% of the total euthecosome population. In the same area over a one year period, Lalli and Wells (1973) found this species present at an average density of 3033 individuals/1000 m^3 of water with a maximum monthly average of 6292/1000 m^3 in August. In a continuation of this study, Wells (1974) observed an average density of 2949.3/1000 m^3 for a two year period.

In the present study, L. inflata was the most abundant species, comprising 38.9% of the thecosomes collected. The individuals ranged in size from 0.16 mm wide to 1.5 mm wide by 0.8 mm high. Using a maturation size of 1.0 mm wide (Wells, 1973), 8.0% of the individuals

collected were adults and 92.0% were juveniles and veligers. The only other works that separated adults and juveniles were Myers' (1968) collections in the Sargasso Sea, for which a mesh size of 0.203 mm (28.5% adults) was used, and Wells' (1973) July collections off Barbados made with a net of 0.076 mm mesh size (7.3% adults).

The juvenile shell has been illustrated by Lalli and Wells (1973). It closely resembles a miniature adult except that no thickened rib and lip-like protrusion are present on the outer edge of the aperture and the body whorl and aperture are only very slightly inflated.

Spoel (1970a), on the basis of the DANA collections, concluded that L. inflata occurred less frequently in real tropical waters. The DANA collections, however, were made with a net of large mesh size and cannot be considered representative for the entire size range of this species.

The horizontal distribution of L. inflata in the Caribbean shows a close correlation between the adults (Figure 2) and the juveniles (Figure 3). The areas of lowest abundance for both groups lie in the central part of the Caribbean along the axis of the main current. The areas of highest abundance are off the north coast of Panama and the northwest coast of Colombia where this species makes up over 50% of the thecosome population in the upper 300 meters. These areas as discussed previously are areas of upwelling. Other areas of abundance are in the waters just west of the passages of the Lesser Antilles. Since McGowan (1960) found the greatest numbers of this species in the Pacific Ocean directly associated with areas of turbulence and vertical mixing, these areas of abundance near the Lesser Antilles could be related to the turbulence and mixing created by the arc of islands. In addition,

Austin (1971) and Williams (1972) found high standing crops in areas of mixing between coastal and pelagic waters and in upwelling areas in the Gulf of Mexico.

As pointed out by Frontier (1973c), the juveniles of L. inflata show a strong tolerance to inshore neritic conditions. Evidence of this is seen (Figure 3) near the coast of Colombia at Station 7 from cruise P-6811 where 15,850 juveniles were collected at the surface. The surface waters there had the high temperature (28.9°C) and low salinity (33.93‰) characteristic of inshore waters in the Caribbean.

As regards vertical distribution, L. inflata has shown evidence of being a stong vertical migrator. Moore (1949) found very marked diurnal vertical migration near Bermuda, with a mean day level somewhat below 300 m and a 33% increase in the population in the upper 250 m at night. In the Florida Current Wormelle (1962) observed upward trends at night but found little difference between the mean day and night levels (4 m difference at one station; 55 m at another). McGowan (1960) and Tanaka (1970) working in the Pacific Ocean and Myers (1968), in the Sargasso Sea, observed maximum concentrations in the upper 25 to 60 m at night, Myers having observed peaks at 0200 and 1900 hours. During the day Tanaka found even distributions from the surface to 400 m while Myers found no adults in the upper 90 meters. Myers reported maximum concentrations of juveniles at the surface at night and at about 50 m during the day. Near Nosy-Bé, Madagascar, Frontier (1973c) found 80 to 90% of the veligers of L. inflata in the upper 100 m during day and night.

In this study the adults' average day level was 265 m and the average night level was the surface. During the day 4.7% of the adults

were collected in the upper 150 m while at night 96.2% were in the upper 100 m. The juveniles were almost always confined to the upper 90 m with 97.4% present there during the day and 99.6% at night. Of the juvenile population 86.2% occurred at the surface during the day and 36.2% at night indicating a possible reverse migration away from the surface at night. An explanation for this indicated migration is apparent on examination of the daytime data. The surface daytime totals are dominated by P-6811 station 7 which makes up 63.0% of the total collected at the surface during the day. As pointed out previously, high abundance is probably a direct result of the juveniles' tolerance for areas of pelagic and neritic mixing and thus is not directly a result of vertical migration. Removing this station from the totals cancels the reverse migration and establishes a slight upward movement at all levels at night.

The large vertical migration (200 to 300 m) the adults undergo in the Caribbean exposes them to a wide range of environmental conditions. Their migration takes place across a very sharp pycnocline and involves passing from a water mass with subtropical characteristics to one with tropical characteristics. During the day the majority of the adults occupied the upper part of a stratum of water historically called the North Atlantic Central Water which is in actuality a mixture of the Subtropical Underwater and the Subantarctic Intermediate Water. In this water the adults predominated within a temperature range of 14-20°C and a salinity range of 35.7-36.7‰ (Figure 4A). At night the adults were found in the Tropical Surface Water within a temperature range of 26-29°C and 34.2-36.3‰ (Figure 4B). The total ranges occupied by the adults were 5-29°C and 32.7-37.0‰.

The temperature and salinity ranges observed in this study agree well with historical data although all historical data are based on cumulative totals and are not separated into day and night groupings. Chen and Bé (1964) in the North Atlantic classified L. inflata as a subtropical cold-tolerant species with a temperature range of 14.2-27.7°C and a salinity range of 35.5-36.7‰. Furnestin (1961) off the northwest coast of Africa collected this species in waters with salinities of 36.30-36.6‰. Rampal (1966) collected it from Mediterranean waters with a 38.6‰ salinity and later (1968) found its maximum abundance at 38.05‰. Williams (1972) in the Gulf of Mexico found a total range of 7-29°C and 34.9-36.4‰. Frontier (1973c) at Nosy-Bé found L. inflata abundant from 24.8-29.0°C and 33.9-35.2‰. He noted that the veligers and juveniles exhibited a tolerance to higher temperatures being found up to near 30°C.

The juveniles and veligers in this study showed a predominance in Tropical Surface Water (Figures 5A and 5B) and exhibited the same temperature and salinity ranges as the adults at night. Overall the juveniles were collected from the same total ranges as the adults because of the presence of large juveniles in the deeper waters.

Limacina lesueurii (d'Orbigny, 1836)

Figure 6A

Tesch (1946) characterized L. lesueurii as a cosmopolitan, rare species that was widely scattered over the whole warmer Atlantic. Spoel (1967) found that the Atlantic distribution was strongly bisubtropical.

This species has never been recorded as abundant in any Atlantic area although Tesch (1946) classified it as common in the Sargasso Sea.

In the Caribbean near Barbados, Lalli and Wells (1973) found an average density of 19 individuals per 1000 m^3 of water over a 12 month period. In the same area Wells (1973) reported an average density for the month of July of 12.0 individuals/1000 m^3 of water comprising 0.7% of the Euthecosomata he collected. Comparable totals were observed in the present study with L. lesueurii making up 0.1% of the total thecosomes. The population was divided almost equally between adults (50.4%) and juveniles (49.6%). The specimens ranged from 0.4 mm wide to 1.3 mm wide and 1.1 mm high. The smallest individuals were easy to identify, being very similar in appearance to the adults. Typically, the small juveniles were wider than high and had the inner whorl(s) projecting only slightly above the body in profile view.

The horizontal distribution of this species showed highest abundances in the Windward Passage (P-6904, stations 13 and 18) and low numbers in the southeast Caribbean. These differences would seem to indicate a preference by L. lesueurii for the subtropical Sargasso Sea waters entering the Windward Passage as opposed to the more tropical waters entering in the southeast Caribbean. These differences in abundance provide support for Spoels' (1967) hypothesis of bisubtropical distribution.

The vertical distribution is poorly documented because this species is rare, but it is generally accepted that L. lesueurii undergoes vertical migration. Wormelle (1962) found individuals as deep as 600 m in the Florida Current with a mean daytime level of 103 m and a mean nighttime level of 85 m. In the Sargasso Sea, Myers (1968) captured no specimens during the day in the upper 150 m and collected only small numbers at night, all in the upper 50 m.

In this study this species showed pronounced vertical migration. During the day 92.9% of the adults were at 224 to 274 m. At night 92.3% of the adults were in the upper 65 m. The juveniles followed the same distributional pattern as the adults. As in the case of L. inflata, the migration of L. lesueurii involves a vertical movement through a steep pycnocline from a water mass with subtropical characteristics to one with tropical properties. During the day the adults were concentrated in waters with temperatures of 9-19.5°C and salinities of 35.8-36.6‰ (Figure 6A). At night they were found in water from 26-29°C and from 35.8-36.6‰ (Figure 6A). The total ranges of temperature and salinity were 7-29.5°C and 34.3-37.0‰.

Chen and Bé (1964) classified this species as subtropical cold-tolerant, living within a temperature range of 14.2-27.7°C and a salinity range of 35.5-36.7‰. Spoel (1967) noted the temperature range as 13.8-27°C. In the Gulf of Mexico Williams (1972) observed a range of 14.1-25.5°C and 35.78-36.42‰.

Limacina trochiformis (d'Orbigny, 1836)

Figures 6B, 7A, 8-11

Tesch (1946) considered this to be a somewhat rare, typically warm water species. Spoel (1967) found that it had clearly discontinuous, bisubtropical distribution. In the Atlantic it was reported as a dominant species in the Sargasso Sea (Chen, 1962; Chen and Bé, 1964; Myers, 1968), in the Florida Current (Wormelle, 1962), in the Gulf Stream (Myers, 1968) and in the southeastern Caribbean (Wells, 1973).

In the present study L. trochiformis comprised 3.0% of the total thecosomes with 43.5% of its individuals being adults. The specimens

ranged in height from 0.5 mm to 1.0 mm. For individuals no higher than 0.7 mm it was difficult to differentiate between L. trochiformis and L. bulimoides. In the adult specimens, the two could be easily separated because the shell of L. trochiformis is approximately as high as wide, with a rounded aperture and no rostrum. L. bulimoides, in contrast, is distinctly higher than wide and has a trapezoidal aperture with a small but distinct rostrum. For the smallest juveniles, however, these adult characteristics were very modified. Rampal (1967) provided illustrative proof of how the shell of L. trochiformis changes with age, using drawings of 9 individuals ranging in size from 0.21 mm to 0.93 mm high. Concerning the series of shells she concluded: "En effet, la coquille très allongée chez le jeune, est globuleuse chez l'adulte." In addition, the aperture is very elongate in small juveniles and only becomes round in the larger juveniles and adults.

The only information on the small juveniles of L. bulimoides is Franc's (1948) statement that: "La coquille, acuminée, possède au niveau des sutures une coloration brune." Franc, however, considered L. trochiformis a synonym of L. retroversa and would have identified the juveniles of L. trochiformis with either L. retroversa or L. bulimoides.

In this study the unidentified juveniles of L. tròchiformis or L. bulimoides were all smaller than 0.7 mm in height with the majority 0.4 mm or less. They had an elongated shell shape with a width to height ratio of less than 1. Their inner apertures were usually light brown. In most cases they were very light brown near the suture.

Although these juveniles could not be identified to species on a morphological basis, a differentiation can be made using the collection

data. All except 6 of the nearly 38,000 unidentified specimens were collected in the upper 100 m. Of these 83.9% were at the surface during the day and 88.8% at night. This vertical distribution compares better with the juveniles of L. trochiformis than L. bulimoides. L. trochiformis is truly an epipelagic species both as an adult and as a juvenile with 99.8% of the juveniles and 99.2% of the adults being collected in the upper 100 m in this study. L. bulimoides, on the other hand, is a strong vertical migrator with 55.3% of the adults and 3 of the 5 juveniles being collected in the Caribbean below 100 m. The day and night temperature and salinity ranges for the unidentified juveniles (Figures 7A and 8A) likewise compare favorably with the juveniles of L. trochiformis (Figures 6B and 8B).

One final consideration in determining the identity of these juveniles is the abundances of the species involved. A total of 1562 adults and 2030 juveniles of L. trochiformis were collected in contrast to 85 adults and 5 juveniles of L. bulimoides. The large number of unidentified juveniles (37,513) would seem to fit better proportionally with the abundant L. trochiformis than the rare L. bulimoides.

By adding the unidentified juveniles to the totals of L. trochiformis, this species becomes the second most abundant in the Caribbean comprising 33.8% of the thecosome population. Of this total, 3.8% are adults and the remainder juveniles and veligers. The only other study listing adults and juveniles separately was Myers' (1968) in November in the Sargasso Sea using a 0.203 mm mesh net. Myers found that 63.6% of the population was juvenile, but this figure is probably low because of the large mesh size of the net.

In the Caribbean, Wells (1973) reported that L. trochiformis

occurred off Barbados in July at an average density of 128.6 individuals/1000 m^3 of water, 7.3% of the total euthecosomes. Lalli and Wells (1973), working in the same area, observed this species at a density of 357 individuals per 1000 m^3 of water over a 12 month period.

The horizontal distribution seems to follow the same pattern as *L. inflata*. The adults (Figure 9) were present only in low numbers along the axis of the main current throughout the Caribbean and in higher numbers in the Atlantic outside Mona Passage and in the counter-current off the coasts of Panama and northwest Colombia. The juveniles (Figure 10) likewise were scarce through the central Caribbean. They were very abundant in the same areas as the adults, and also within the Windward Passage.

Wormelle (1962) found evidence of vertical migration of this species in the Florida Current. She recorded a mean day level of 165 m and a mean night level of 99 m on the west side of the current, and a mean day level of 88 m and a night level of 120 m on the east side. Myers (1968) observed no clear migratory pattern, with maximum concentrations at 50 meters at 1130 and 1700 hours. He found no adults below 100 m at any time.

In the present study, the juveniles and, to a lesser degree, the adults were restricted in their vertical movements to the upper waters above the thermocline and the Subtropical Underwater. Within these upper waters, some diurnal migration did appear to take place. The adults exhibited an average day level of 50 m with 4.4% at the surface. At night the average depth was 34 m with 45.7% at the surface. The juveniles had an average day level of 35 m (6.4% at the surface) and a night level of 34 m (28.0% at the surface).

L. trochiformis principally occupies only one water mass in the

Caribbean, the Tropical Surface Water and as a result is exposed to a limited temperature range and moderate salinity fluctuations. During the day, the adults occupied mainly a range of 26.5-28°C and 35.75-36.3‰ (Figure 11A). Most adults were found in waters of 26-29°C and 34.25-36.2‰ at night (Figure 11B). The juveniles primarily occurred within ranges of 25.5-28°C and 35.75-36.3‰ during the day (Figure 8B) and 26-29°C and 35.25-36.25‰ at night (Figure 6B). The total ranges observed for adults were 5-29.5°C and 34.0-37.0‰ and for juveniles were 4-29.5°C and 32.7-37.0‰. Historically L. trochiformis has been observed within a range of 14.2-27.7°C and 35.5-36.7‰ in the North Atlantic (Chen and Bé, 1964); 13.8-27.9°C and 35.5-36.8‰ (Spoel, 1967), and 7.1-31.0°C and 34.95-36.68‰ in the Gulf of Mexico (Williams, 1972).

Limacina bulimoides (d'Orbigny, 1836)

Figure 12A

Limacina bulimoides was characterized by Tesch (1946) as a cosmopolitan, tropical species which was abundant in the Sargasso Sea. Later workers found it second in abundance at one station in the Sargasso Sea and third at another station (Chen and Bé, 1964); rare in the Florida Current (Wormelle, 1962); rare in the Gulf of Mexico (Austin, 1971; Williams, 1972) and abundant in the Benguela Current (Morton, 1954b). In the Caribbean near Barbados in the month of July, Wells (1973) found it comprising 5.2% of the euthecosomatous population at an average density of 92.3 individuals/1000 m^3 of water.

In this study L. bulimoides comprised only 0.1% of the thecosome population with 94.4% of its individuals being adults. The specimens ranged in height from 0.7 to 1.6 mm. Very few juveniles were collected although it is possible that some are included in the "Limacina

trochiformis or Limacina bulimoides Juveniles" as discussed previously.

The horizontal distribution showed high numbers in the Windward Passage (P-6904, stations 13, 14 and 15) and very low numbers in the southeast Caribbean. As in the case of L. lesueurii, this species appears to have a preference for more subtropical waters.

In regard to the vertical distribution of this species, Moore (1949) reported a mean day level of 80 m near Bermuda. Morton (1954b), on the basis of two stations in the Benguela Current, concluded that the large individuals migrated upwards at night and the small individuals showed little tendency to migrate at all. At a late afternoon station, he had found a distributional range from 0-50 m to 750-1000 m with a maximum abundance (79.7%) at 50-100 m. Later that evening, at a station approximately 40 miles away, the distribution ranged from 0-50 m to 750-1000 m with maxima at 0-50 m (22.8%) and 100-250 m (64.2%). Analysis of size distributions at the levels of maximum abundance showed that the proportion of large individuals was highest in the waters near the surface at night while the proportion of small individuals was highest in waters from 100-250 m at night. Morton's conclusions may certainly be true but just as equally the differences in distribution could have arisen from patchiness in distribution between the two separated stations, as suggested by McGowan (1960).

Wormelle (1962) found a maximum in abundance at 120 m on the east side of the Florida Current. Myers (1968) in the Sargasso Sea found no individuals of this species in the upper 100 m during the day. Shortly before sunrise and at sunset he found maximum numbers near the surface, and from 2000 to 0300 hours he observed a downward migration.

In the present study all of the adult *L. bulimoides* were collected below 225 m during the day. At night 97.1% were collected in the upper 53 m with 20.6% at the surface. Too few juveniles were collected to analyze their distribution.

In the Caribbean the migration of this species, as with *L. inflata* and *L. lesueurii*, takes place across the pycnocline and involves passage from subtropical to tropical waters. The highest numbers of *L. bulimoides* occupied waters of 26-28.5°C and 35.3-36.3‰ at night, compared to 17.5-19.5°C and 36.2-36.7‰ during the day (Figure 12A). The total ranges for this species were 8.5-29.5°C and 34.3-37.0‰.

In comparison Chen and Bé (1964) reported it from a range of 14.2-27.7°C and 35.5-36.7‰ in the North Atlantic; Spoel (1967) reported it from 13.8-27.8°C and 35.5-36.7‰; and Williams (1972) collected it from 20°C and 36.18‰ in the Gulf of Mexico.

Genus *Creseis* Rang, 1828

Creseis acicula (Rang, 1828)

Figures 8C, 8D, 12B-15A

The systematics of all species belonging to the genus *Creseis* have historically been very problematical. The genus has ranged from being monospecific to having four species, and its respective species, subspecies and formae have been alternately raised or lowered in taxonomic rank and have been lumped or split into a multitude of groups.

Creseis acicula has always included the true *acicula* form as described by Rang (1828) and on occasion has included either as a subspecies or forma, a *clava* form also described by Rang (1828). In his original description, Rang considered *acicula* a variety of *clava*. He described *acicula* as nearly straight except for some twisting over

parts of the shell length and _clava_ as perfectly straight. After observing many more shells, Rang & Souleyet (1852) established _clava_ as a variety of _acicula_ and augmented his descriptions by noting that _clava_ was proportionally smaller. Strictly speaking, however, it should have priority over _acicula_ because _acicula_ was described as a variety of _clava_ and because _clava_ had page priority over _acicula_. Spoel (1967) reached the same conclusion. All later workers have used _acicula_ as the species name; thus that practice will be followed here.

Rang's (1828) original description of _clava_ has not often been followed. Tokioka (1955), Chen and Bé (1964), Myers (1968), Austin (1971) and Williams (1972) all identified straight-shelled specimens with swollen embryonic tips as _clava_. In all probability, these were juveniles of _Cuvierina columnella_ (_vide infra_, _Cuvierina columnella_).

When the entire shell and especially the embryonic tip of _clava_ are examined, it does appear that _clava_ is closer to _Creseis acicula_ than the other species of _Creseis_. In addition, on the basis of the embryonic tip, the _clava_ form can be separated from other straight-shelled forms belonging to _Creseis virgula_ or _Cuvierina columnella_. The _clava_ form, however, should be considered at no higher taxonomic level than forma since there are so many intermediates between it and _acicula_ (Spoel, 1967).

Creseis acicula was represented only by the forma _acicula_ in this study. There were numerous specimens without shells which possibly belonged to _C. acicula f. clava_, but no shelled specimens of this forma were collected.

Tesch (1946 and 1948) characterized _C. acicula_ as a cosmopolitan, warm water species with its highest abundance away from equatorial

waters. Spoel (1967) also noted this bisubtropical tendency and indicated that it was not based on presence or absence but on relative abundance. Chen and Bé (1964) reported this species as one of the most abundant in the Sargasso Sea. Wormelle (1962) found it among the most abundant of the Cavoliniidae in the Florida Current. Wells (1973) reported C. acicula comprising 0.9% of the euthecosomes off Barbados in July with an average density of 16.6 individuals/1000 m^3 of water.

C. acicula is able to penetrate farther into neritic waters than any other thecosome. Stubbings (1938), Prasad (1956, 1958), Tampi (1959) and Frontier (1966b, 1973b) have documented this inshore tendency in the Indian Ocean as have Kornicker (1959), Hutton (1960) and Hopkins (1966) in the Gulf of Mexico; Vives (1966) in the Mediterranean Sea and Owre and Foyo (1972) in the Atlantic near the coast of South America.

In this study, C. acicula made up 2.5% of the thecosomes collected with 36.9% being adults. The specimens ranged in size from 0.4-0.5 mm long to 10.7 mm long by 0.8 mm wide at the aperture. Individuals smaller than 0.5 mm long were shorter than the length of a complete embryonic shell and could not be identified to species.

Two specimens in what Spoel (1967) has termed the "skinny" stage of development for Cavoliniidae were collected in the Mosquito Gulf at a depth of 225 m. Spoel (1967) reported "skinny" forms for C. virgula but this is the first record of their occurrence in C. acicula.

The horizontal distribution of this species (Figures 13 and 14) showed highest abundances both for the adults and juveniles in areas near land masses. Lowest abundances occurred in the central Caribbean.

Stubbings (1938), in an early report on vertical distribution in the Arabian Sea, found a maximum concentration of _C. acicula_ during the day at 250 m and a total range of 500 m. Moore (1949) observed a mean day level of 30 m near Bermuda. In the Mediterranean, Menzies (1958) found this species most abundant between the surface and 100 m depth with a migration toward the surface at night. In the Florida Current, a mean day level of 157 m and a night level of 52 m with nighttime concentrations at the surface were recorded by Wormelle (1962). In the Sargasso Sea, Myers (1968) found a maximum concentration for the adults at 50 m during the day and a rise toward the surface at sunrise and sunset with a few individuals below 100 m during the day. Juveniles were always in the upper 100 m there with greatest numbers at 50 m at 2300 hours.

In the Caribbean during the day 96.5% of the adults were found in the upper 65 m with 68.9% at the surface. Of these individuals collected at the surface 81.7% were from two stations (P-6811, station 7 and P-6904, station 3) which have strong indications of upwelling near the surface. These stations will be discussed further in the next section.

At night 98.6% of the adults were collected within the upper 52 m, and 79.7% were at the surface. The distribution of juveniles by day was 95.5% in the upper 90 m (41.2% at the surface) and by night was 99.5% in the upper 75 m (77.6% at the surface).

Because of its tolerance of neritic and oceanic waters _C. acicula_ is exposed to the widest range of water conditions of any thecosome. For example, Prasad (1958) found this species living within a temperature range of 23.5-31.0°C and a salinity range of 24.76-37.45‰ over

a 5 year period in inshore Indian Ocean Waters. Tampi (1959) reported collecting specimens from 32.4°C and 31‰ in a saltwater lagoon in the same area. Spoel (1967, 1971b) and Williams (1972) referred to Tampi's article and reported ranges of 26-33°C and 25-45‰. The ranges they listed, however, were the hydrographic extremes in the lagoon over a one year period when only those in the month of capture of this species, May, should have been given.

C. acicula has also been reported from waters of 16.8-27.9°C and 35.6-36.7‰ in the Sargasso Sea (Chen and Bé, 1964); 16.5-19.45°C and 37.41-38.08‰ in the western Mediterranean (Rampal, 1967); 26.0-28.0°C and 31.79-33.03‰ and 23.7°C and 33.90‰ in inshore waters near Cape Hatteras (Myers, 1968); 27.5°C and 20.36‰ in the outflow of the Amazon River (Owre and Foyo, 1972) and 12.5-30.0°C and 34.95-36.50‰ in the Gulf of Mexico (Williams, 1972).

In the Caribbean the preferred ranges for C. acicula f. acicula adults were 26.5-29.0°C and 34.0-36.3‰ during the day (Figure 12B) and 27.0-29.0°C and 34.3-36.2‰ at night (Figure 8C). The juveniles were more restricted, found at 26.5-28.0°C and 35.5-36.2‰ during the day (Figure 15A) and 27.5-29.0°C and 35.3-36.2‰ at night (Figure 8D). The total ranges for the adults at the species level were 5-29.5°C and 32.7-36.9‰ and for the juveniles were 9.0-29.5°C and 32.7-37.0‰. Combining the results of this study with historical records reveals that C. acicula has a range in temperature of 5-31°C and a total range in salinity of 20.36-38‰.

Creseis virgula (Rang, 1828)

Figures 7B, 16-17C

The taxonomy of Creseis virgula has been even more problematical than that of C. acicula. Most authors have agreed that this species

includes the two forms *virgula* (Rang, 1828) and *conica*, Eschscholtz, 1829 as either subspecies or formae. *C. acicula* f. *clava* has also often been included in this species, but as discussed previously, it belongs with *C. acicula*.

The problems in identification have arisen, however, in interpretation and application of the original descriptions. Rang (1828) described *Cleodora (Creseis) virgula* as: "Coquille incolore, un peu moins transparente, unie, recourbée aux deux tiers de sa longueur; ..." Rang's illustration shows a shell which is straight in the anterior part and which has a distinct curvature starting at approximately 2/3 of the total length from the aperture. Eschscholtz (1829) described *Creseis conica* as: "Die Schaale ist 2 Linien lang, glatt und gerade, an der Basis weit mit runder oeffnung, hinter der Mitte verengert sie sich plötzlich; ..." Eschscholtz's illustration shows a straight shell with a weak constriction starting at 5/6 of the total shell length from the anterior end, followed by a slight expansion and then a tapering to the posterior tip.

Pelseneer (1888a), in a logical extension of the original description, classified *virgula* as having a shell "with a marked abrupt dorsal curve and with the transverse diameter increasing rapidly at the point of the curvature." He described *conica* as a separate species and noted that it had "a slight and regular dorsal curvature; the transverse diameter increasing gently and uniformly; ..." He provided no illustration of *virgula* but his illustration of *conica* shows a shell that is almost entirely straight with only a slight curvature taking place over the entire shell.

Tesch (1913), treating the two forms at the subspecies level, followed Pelseneer's descriptions and classified *virgula* as: "Schale

glasartig, stets deutlich dorsal gekrümmt; der vordere Teil, der etwa zwei Drittel der Länge der Schale einnimmt, ist gerade; der hintere Teil zeigt eine mehr oder weniger schroff gegen den anderen Teil der Schale abgesetzte, dorsale Krümmung." He described conica as: "Schale farblos, sehr schwach dorsal gekrummt, die Krümmung ist nicht scharf, abgesetzt, sondern erfolgt allmählich." In 1948 Tesch shifted his emphasis in distinguishing the two forms. He illustrated 10 individuals, 7 of which belonged "to the distinctly curved (and generally much smaller) virgula" and 3 "in which the breadth of the shell remains practically the same in the straight part," which he assigned to conica.

On the basis of his 1913 descriptions, all three of his forms of conica would be classified as virgula because they were straight over the anterior 2/3 of the shell and then distinctly curved over the posterior third. His distinction of 1948, based on the breadth of the shell remaining constant in the straight part, appears to be of dubious taxonomic value. Two of the forms he illustrated as virgula appear to have the character of constant breadth similar to the three conica forms.

Chen and Bé (1964), also treating the forms at the subspecies level, used Tesch's 1913 descriptions but included new characteristics based on the embryonic shell. They classified as virgula those individuals with a distinct shell curvature and no constriction between the embryonic and adult parts of the shell, and as conica, those with straight or slightly curved shells and no constriction between the embryonic and adult parts of the shell. The individuals with straight shells and a slight constriction between the embryonic and adult parts, they classified as clava. These forms were in all likelihood juveniles

of Cuvierina columnella as will be discussed later. For the specimens with straight or slightly curved shells and a distinct constriction between the adult and embryonic parts, they created a new subspecies, constricta. Their creation of a new subspecies does not seem to be a necessary step since the original illustration by Eschscholtz shows a weak constriction between the adult shell part and the embryonic shell part, and the adult shell parts of conica and constricta are identical. In addition, there are individuals with constrictions ranging from the weak type of conica to the strong type of constricta.

Frontier (1965), studying "Le Probleme des Creseis," attempted to determine quantitatively the difference in amount of curvature between conica and virgula. He measured the angle made by the longitudinal axis of the adult shell part with the axis of the embryonic shell. These measurements revealed two distinct groups, those with angles of 0 to 20° (conica) and those with angles from 30 to 90° (virgula).

The most recent development in treatment of this species was Spoel's (1967) work in which he reversed the descriptions of virgula and conica. He considered both as formae of C. virgula and described C. virgula f. virgula as gradually but distinctly curved dorsally with a small constriction separating the adult and embryonic shell parts. C. virgula f. conica he described as having a straight anterior part of the shell with the posterior top curved dorsally and with no constriction separating the adult and embryonic shell parts. Even though Spoel interchanged what have traditionally been considered virgula and conica, he did not transpose the synonymies. For example, his synonymy for virgula contained all of the frequently cited references on virgula, even though his description referred to what has historically been

called conica.

Spoel (1970a) included in his forma virgula individuals with entirely straight shells and a constriction separating the embryonic and adult parts of the shell. These individuals would appear to correspond very closely to Eschscholtz's original description and illustration of conica.

Typical examples of the two formae of virgula collected in this study are illustrated in Figure 16.

The forma conica was represented by individuals with nearly straight shells (Figure 16B) or gradually curved shells (Figure 16A) usually with a slight constriction separating the adult and embryonic shell parts. The forma virgula was represented by shells that were straight over the anterior two-thirds, distinctly curved over the posterior third, and lacked a constriction between the adult and embryonic shell parts (Figure 16C). The shell of virgula was proportionally wider than conica. The embryonic shells of both formae were identical.

Creseis virgula was characterized by Tesch (1946) as a typically tropical species which was much less common in the Atlantic than C. acicula. Spoel (1967) cited the general distribution of C. virgula as comparable to C. acicula and noted that the forma conica had a more tropical character than the forma virgula.

Very little distributional information is available for the formae. Most authors worked only at the species level, lumping both formae together. Some authors such as Russell and Colman (1935) even lumped all the species of Creseis together and discussed collectively the "creseids."

Among those authors who did not differentiate between infraspecific

forms, Moore (1949) found _C. virgula_ to be comparatively rare in the Sargasso Sea; Wormelle (1962) found it as one of the commonest species in the Florida Current; and Lewis and Fish (1969) reported it as one of the most abundant species at the surface near Barbados. In a two year study Lewis and Fish observed sporadic fluctuations in abundance with a sharp peak from May through July during the second year.

Others distinguished between infraspecific forms. Austin (1971) found that in the Florida Current the _virgula_ form was the most common thecosome in the upper 25 m, and in the Gulf of Mexico the _conica_ form was highly tolerant to shelf waters and occurred there in abundance. Burkenroad (1933) reported _conica_ from inshore waters off the Louisiana coast. However, Chen and Hillman (1970) and Myers (1968) reported _conica_ as one of the main indicators of Gulf Stream water off Cape Hatteras. Off Barbados, Wells (1973) collected the forma _virgula_ at an average density of 34.8 individuals/1000 m^3 of water (2.0% of the total euthecosomes), whereas the forma _conica_ occurred in the same collections at an average density of 384.5 individuals/1000 m^3 of water (21.7% of the euthecosomes).

In the present study _C. virgula_ comprised 1.5% of the thecosomes collected, with 56.1% of these being juveniles. Since specimens of _C. virgula_ could not always be identified to forma, it would be inaccurate to compute relative abundances of the two formae. Of the identified formae, however, _C. virgula_ f. _conica_ was approximately 18 times more abundant than _C. virgula_ f. _virgula_.

These specimens of forma _virgula_ ranged from 1.0 mm long to 4.2 mm long and 1.0 mm maximum diameter. The specimens of _conica_ measured 0.8 mm long to 5.0 mm long and 0.9 mm maximum diameter.

Too few of the forma virgula were collected to permit evaluation of its horizontal distribution. The forma conica was uniformly distributed except for areas of low abundance throughout the center of the Caribbean along the axis of the main current.

The vertical distribution of the two formae was similar, the juveniles and adults of both always occuring in the upper 80 m. The two formae also showed a tendency to migrate away from the surface at night. During the day 42.9% of the adults of virgula were at the surface compared with 39.7% at night; 54.8% of the adults of conica and 4.0% of the juveniles were found at the surface during the day while 2.5% of the adults and 1.1% of the juveniles were there at night.

The only previous study treating vertical distribution at the infraspecies level is Myers' (1968) in the Sargasso Sea off Cape Hatteras. He found the adults of conica concentrated in the upper 50 m and showing discernible migratory pattern, whereas conica juveniles were randomly distributed in the upper 100 m throughout the day. He did not collect sufficient specimens of virgula to study its distribution. All other studies of vertical distribution considered only the species *C. virgula* as a whole. Stubbings (1938) found maxima at the surface from 1300-1400 hours and at 1018 hours, but Menzies (1958) reported higher surface abundances in the Mediterranean during the night than during the day. In the Florida Current Wormelle (1962) observed mean day levels of 62 and 206 m on the western side of the current and 319 on the eastern side. Corresponding mean night levels were 98 on the western side and 167 m on the eastern side. Wormelle's data suggest a strong vertical migration toward the surface during daytime and a large vertical depth range for *C. virgula*. Both historical information and the present study indicate that

C. virgula is an epipelagic species that shows very little vertical migration.

Since both formae occupy such a small depth range near the surface in the Caribbean, they experience a restricted temperature range and moderate salinity fluctuations. The majority of the adults of *C. virgula* f. *virgula* and *C. virgula* f. *conica* have temperature and salinity ranges of 26-29°C and 34.3-36.3‰ (Figures 7B, 17A and 17B). The juveniles occupy the same ranges except that those of *conica* are found from 24-28°C and 35.4-36.7‰ during the day (Figure 17C). In comparison, Williams (1972) found slightly different ranges for each forma in the Gulf of Mexico recording 24.8-25.5°C and 35.78-35.86‰ for *virgula* and 13.3-31.0°C and 34.95-36.51‰ for *conica*.

Creseis chierchiae (Boas, 1886)

Figures 17D, 18

Historically, two different species have been recognized as *C. chierchiae*. The original species described by Boas (1886) is a minute species ranging in size to 2.5 mm long and 0.6 mm wide. It is characterized by strong transverse striations except on the embryonic shell and by an embryonic shell very similar to that of *C. virgula*. The shell aperture is rounded, with no lip.

The other species was described as *C. chierchiae* by Menzies (1958) on the basis of 13 specimens collected in the Mediterranean. His specimens had strong transverse striations except on the embryonic shell, which was bluntly rounded unlike that of *C. virgula*, and a dorsal lip projecting out over the aperture to its midpoint. McGowan (1960) and Frontier (1963b, 1965) pointed out the differences between Menzies' specimens and Boas' original description. Two later workers, however,

Chen (1962), in the western North Atlantic, and Myers (1968) in the Sargasso Sea, identified specimens that were identical to Menzies' as C. chierchiae. The only other records of C. chierchiae in the Atlantic are Dall's (1889) off "Georgia" and Legaré's (1961) in the Cariaco Trench. Since neither citation includes a description or illustration of the species, the only form known from the Atlantic is that described by Menzies. On the other hand, Pacific and Indian Ocean records that include a description or illustration are confined to C. chierchiae (Boas, 1886).

In the present study 54 individuals of the species designated as C. chierchiae by Menzies were collected (less than 0.1% of the total thecosomes), and none represented the true C. chierchiae. The specimens (Figure 18A and B) ranged in length from 0.4 mm to 0.9 mm and measured 0.16 mm in maximum diameter. These specimens definitely do not belong to C. chierchiae (Boas, 1886). Not only do they differ from his species on the basis of the characters previously described but also in the one character that provides a superficial resemblance between the two, the transverse striations. The striations of C. chierchiae are much narrower and closer together than those of the Caribbean specimens. In an equal distance C. chierchiae has approximately five times as many striations. Since the aperture of the largest specimens had a lip growing from the dorsal edge almost halfway across the aperture, any further increases in shell length would seem to be precluded and the possibility that this form is a juvenile of another species eliminated.

The horizontal distribution of this species was restricted to waters west of 73°W in the Caribbean, which suggests that it originates

in the subtropical Sargasso Sea waters entering the Windward Passage. The fact that Wells (1973) collected none off Barbados is further evidence of its absence in the eastern Caribbean.

All specimens except one were collected in the upper 52 m, with individuals occurring at the surface during both day and night. Menzies (1958) collected his specimens from the surface at night. The daytime and nighttime salinity and temperature ranges are shown in Figure 17D. The ranges recorded in the Caribbean are 27-28°C and 34.9-36.3‰ with one specimen collected from 18.5°C and 36.6‰.

Genus Styliola (Quoy and Gaimard, 1827)

Styliola subula (Quoy and Gaimard, 1827)

Figures 15B, 18C-21A, 22A, 22B

Tesch (1946) cited this species as the most abundant of the Cavoliniidae in the Atlantic Ocean and noted its discontinuous distribution in terms of relative abundance, having found the greatest numbers north of 10° N and south of 10°S. Chen and Bé (1964) reported it as the third and fourth most abundant euthecosome at two stations in the Sargasso Sea, but Wormelle (1962) reported it as only 5.9% of the thecosome population near Bermuda and 5.3% in the Florida Current. In the Caribbean off Barbados, Wells (1973) collected S. subula at an average density of 6.0 individuals/1000 m^3 of water (0.3% of the euthecosome population) in July, and the average density in the same area over a two year period (Wells, 1974) was 18.5 individuals/1000 m^3 of water. In this study S. subula made up 5.5% of the total thecosome population with 93.8% being juveniles. The individuals measured 0.3 mm long to 7.9 mm long and 1.5 maximum diameter. One individual in the "skinny" stage

of development was collected off the north coast of Honduras at a depth of 531 m.

The embryonic shell of S. subula can be recognized by its acutely pointed tip and its large area of constriction (Figure 18C).

The horizontal distribution of this species (Figures 19 and 20) reflects its preference for subequatorial waters. The juveniles (Figure 20) especially are more abundant in the Sargasso Sea waters entering through the Windward Passage than in the tropical waters entering the southeastern Caribbean. In Wells' (1973) study off Barbados, S. subula was caught in approximately equal numbers in a net with a large mesh and a net with a small mesh, indicating a lack of very small juveniles in that area.

S. subula has been shown to be a strong vertical migrator by Moore (1949), who observed a diel range of migration of at least 272 m and a mean day level of 60 m near Bermuda, and Menzies (1958) who found it absent from the surface during the day in the Mediterranean and most abundant at the surface at night. Also, Wormelle (1962) reported mean day levels of 234 and 184 m and a mean night level of 81 m on the west side of the Florida Current, and on the east side, mean levels of 594 in the day and 171 m at night. Hartmann and Weikert (1971), in studies of the 0 to 10 cm microlayer west of the Madeira Islands, found S. subula absent during the day and present at night, with a maximum abundance near sunset and a slightly lower abundance near sunrise. In the Sargasso Sea, Myers (1968) found no adults in the upper 75 m during the day but found peaks of abundance near the surface shortly after sunset and before sunrise. The juveniles showed a similar, but not as pronounced pattern and remained to a certain extent near the surface waters

during the daytime.

The results of this study agree well with the historical data. The adults of S. subula had an average day depth of 265 m and an average night depth of 31 m. No adults were found at the surface in the daytime and only 46.5% were found in the upper 90 m. At night 19.9% were collected at the surface and 97.2% in the upper 81 m. For the juveniles the average day level was 30 m and the average night level was 48 m. During the day 1.0% of the juveniles were at the surface and 95.5% were in the upper 90 m. At night 3.1% were at the surface and 99.7% in the upper 75 m.

The large migration by the adults and to a lesser extent by the juveniles subjects them to a wide range of environmental conditions. Chen and Bé (1964) recorded the total range for the species in the North Atlantic as 14.2-27.7°C and 35.5-36.7‰. Williams (1972) observed a range of 14.1-24.5°C and 35.70-36.26‰ in the Gulf of Mexico. In this study the adults during the daytime were collected in water from 5-19.5°C and 35.0-36.7‰ and 25.5-28°C and 36.0-36.4‰ (Figure 15B). At night the majority of the adults were found in waters of 26-28.5°C and 34.3-36.3‰ (Figure 21A). The juveniles exhibited similar, though somewhat reduced, ranges. During the day their ranges were 13-28°C and 35.8-36.7‰ (Figure 22A), and at night the majority had ranges of 26-28.6°C and 35.6-36.2‰ (Figure 22B).

S. subula, by virtue of its strong vertical migration, crosses a sharp pycnocline at sunrise and sunset, occupying waters of subtropical characteristics during the day and tropical characteristics at night.

Genus *Hyalocylis* Fol, 1875

Hyalocylis striata (Rang, 1828)

Figures 21B, 21C, 23A, 23B, 24A

A tropical species living principally between 30° N and 10°S, *H. striata* is most abundant just north of the equator (Tesch, 1946). It has been reported as rare in the western North Atlantic (Chen and Bé, 1964), in the Sargasso Sea (Moore, 1949; Chen and Bé, 1964), and in the Florida Current (Wormelle, 1962). Wells (1973) reported this species as the least abundant euthecosome (0.02% of the population) near Barbados in the month of July, with an average density of 0.4 individuals/1000 m^3 of water. *H. striata* was also rare in the present study, comprising 0.2% of the thecosomes collected. Only 10.8% were juveniles. The specimens ranged in size from 1.7 mm to 5.8 mm long by 1.7 mm wide.

H. striata is a species that casts off its embryonic shell part and forms a closing septum at the place of rupture at an early age. Tokioka (1955) reported a specimen 1 mm long that had already lost its embryonic shell. In fact, the juveniles of *H. striata* have very rarely been collected with the embryonic part still attached. This species, therefore, must spend only a very brief time in the developmental stage from hatching to casting off the embryonic shell. This rapid development could account for the lack of specimens smaller than 1.7 mm long in this study.

An empty shell measuring 0.7 mm long and 0.15 wide that could have been a juvenile stage of *H. striata* was collected in the Gulf of Darien from a depth of 50 m (Figure 23A and B). The shell is conical, has transverse striations and shows a slight curvature, all characteristics of *S. striata*. The diameter of the shell at the aperture is 0.15 mm.

According to Tokioka (1955), Chen and Bé (1964), Spoel (1967), Myers (1968) and present data, the diameter at the point of rupture of the embryonic shell from the adult shell measures from 0.15-0.40 mm, and thus the empty shell could be Hyalocylis striata.

Descriptions and illustrations of the embryonic tip of H. striata are few, and poorly delineated. Fol (1875) and Pelseneer (1888a) showed a distinctly expanded shell having a rounded apex, which was droplet shaped and separated from the adult part by a distinct constriction. Tesch (1904) described an embryonic shell which was much blunter at the apex and had two areas of constriction, one separating it from the adult shell and the other in the middle of the embryonic portion. The form illustrated in Figure 23A and B is intermediate between descriptions by Pelseneer and Tesch. The shell has only one area of constriction (like Pelseneer's) and has a partially blunt tip (like Tesch's). The shell diameter differs from both, however, lacking a rapid expansion immediately above the embryonic part.

Spoel (1967) contended that the embryonic shells illustrated by Fol (1875), Pelseneer (1888a) and Tesch (1904) were "incorrectly figured" and would not fit onto the shell of the adult of H. striata. Spoel believed that Creseis chierchiae (Boas, 1886) could better be accepted as the juvenile of H. striata. C. chierchiae, however, has approximately 35 transverse striations per mm of shell (Frontier, 1963b) compared to 18 to 20 per mm for small H. striata (Tokioka, 1955; present study). In addition, C. chierchiae has been regularly collected at a size of about 2 mm long with some specimens up to 2.5 mm long (Frontier, 1965). The embryonic shell of these individuals measured 0.4-0.5 mm long, indicating that if the embryonic tip were

cast off, the specimens of *C. chierchiae* would still be from 1.5-2.0 mm long. This length is larger than the size when the embryonic part should have been cast off. As reported by Tokioka (1955), the embryonic shell was already missing from a shell 1 mm long.

The horizontal distribution of *H. striata* is uniform throughout the Caribbean with the exception of areas of very low abundance through the central Caribbean along the axis of the main current.

Stubbings (1938) was the first to substantiate the vertical migration of this species in the Indian Ocean. He collected it at 200-500 m during the day and at the surface at night. Menzies (1958) reported a similar distribution in the Mediterranean, finding this species at the surface at night but not during the day. Wormelle (1962) found *H. striata* in the Florida Current at a mean day level of 283 m and a mean night level of 84 m. Myers (1968) reported both the adults and the juveniles in the Sargasso Sea to be generally absent from the upper 150 m during the day, with a maximum concentration at 50 m at night.

In the present study the adults and juveniles showed strong vertical migratory tendencies. During the day the adults occurred at an average depth of 243 m, with 1.8% at the surface and 26.8% in the upper 90 m. At night the adults occurred at an average depth of 34 m with 32.9% at the surface and 100% in the upper 81 m. The juveniles, though rare, showed similar distributions.

During the day the adults occupied water strata characterized by 14-19° C and 35.8-36.7‰ and by 25-27.5° C and 35.8-36.7‰ (Figure 24A). At night, the ranges were 26-29° C and 34.3-36.3‰ (Figure 21B). For the juveniles the day ranges were 17-25.5° C and 36.3-36.7‰ and at night

26-27.5°C and 36.2-36.3‰ (Figure 21C). In comparision, Rampal (1967) collected _H. striata_ from waters of 21.7°C and 39.07‰ in the Mediterranean. Williams (1972) recorded a total range of 18.6-25.5°C and 35.80-36.68‰ in the Gulf of Mexico.

Genus _Clio_ Linnaeus, 1767

Clio pyramidata Linnaeus, 1767

Figures 23C, 24B

Clio pyramidata is a cosmopolitan species, and occupies a range in the Atlantic Ocean, extending from the Antarctic continent in the south to 65° N (Spoel, 1967). This species shows clinal variation in its geographic distribution especially in the Atlantic Ocean. In the tropical and subtropical Atlantic, _C. pyramidata_ f. _lanceolata_ is the dominant forma, with seasonal intrusions of the forma _pyramidata_ in the north and the forma _antarctica_ in the south. The forma _martensii_ described by Pfeffer (1880) could be a tropical or subtropical forma. Pfeffer described it on the basis of 22 individuals collected in the "Atl. Oc." and the "Antillen" but gave no more specific locations, and _martensii_ has never again been reported. In the present study only the forma _lanceolata_ was identified, although there were numerous specimens of _C. pyramidata_ that could not be identified to forma.

The embryonic shell of forma _lanceolata_ (Figure 23C) can be distinguished by the wide, slightly swollen ring at its anterior end, by the widest part of the shell being approximately 1/4 of the total shell length from the anterior end, and by the sharp caudal tip, which resembles the posterior part of the embryonic tip of _Styliola subula_

(Figure 18C) but is proportionally much larger.

A few C. pyramidata were collected in the Sargasso Sea (Moore, 1949; Chen and Bé, 1964), in the Florida Current (Wormelle, 1962), and in the Gulf of Mexico (Austin, 1971; Williams, 1972). In the Caribbean, Wells (1973) collected C. pyramidata at an average density of 3.6 individuals/1000 m^3 of water; these represented 0.2% of the euthecosomes collected. In this study C. pyramidata constituted 0.1% of the thecosome population. Juveniles made up 85.1% of the individuals. The specimens measured from 0.4 mm to 8.7 mm long by 7.9 mm wide.

Neither the horizontal nor vertical distribution could be evaluated because of the small number of specimens collected. The juveniles were collected from 224-531 m during the day, with an average depth level of 445 m. At night fewer specimens were captured, with 23 juveniles occurring from 65 m and one from 258 m.

Stubbings (1938), on the basis of small numbers of specimens from the Indian Ocean, reported a daytime range of 250 to 900 m, with a maximum concentration from 400 to 500 m. He found individuals at night spread uniformly from the surface to 1500 m. Myers (1968) found a few adults in the upper 50 m only at sunset in the Sargasso Sea. The juveniles he collected were absent from the upper 50 m except from 1600-2100 hours when they were present near the surface. Spoel (1973) collected C. pyramidata f. lanceolata near Bermuda at a vertical range of 350-950 m during the day and 50-550 m at night and postulated an average distance of vertical migration of 330 m.

Because of the small number of specimens, few conclusions can be made about the temperature and salinity preferences of lanceolata.

The juveniles were collected within a range of 12-19°C and 35.6-36.6‰ during the day (Figure 24B). At night 23 juveniles were collected from waters of 27.5°C and 36.26‰ and 1 juvenile from 18.8°C and 36.62‰ (Figure 24B). The total range for C. pyramidata (adults and juveniles combined) was 12-28°C and 35.5-37.1‰. Chen and Bé (1964) reported a range for C. pyramidata in the North Atlantic of 14.2-27.7°C and 35.5-36.7‰. Williams (1972) observed a total range of 8.0-24.5°C and 34.95-36.25‰ for this species in the Gulf of Mexico.

Clio cuspidata (Bosc, 1802)

Figure 25A

Spoel (1967) depicted an unusual distribution in the Atlantic Ocean for this species. The majority of the population was found east of 40° W from 65° N to 20° S with only a small population in the western Atlantic associated with the Antilles Current and the Florida Current. To Spoel's distributional pattern should be added collections near Bermuda (Chen, 1962), in the Gulf of Mexico (Austin, 1971; Williams, 1972) and in the Caribbean (present study), indicating a probable connection between the eastern and western Atlantic populations through equatorial waters. This species was previously not reported from the Caribbean, being notably absent from Wells' (1973) collections made to a depth of 350 m off Barbados. The revised geographic distribution indicates a preference for tropical and subtropical waters with some penetration into certain temperate waters.

In this study one adult and 15 juveniles comprising less than 0.1% of the total thecosomes were collected. The specimens were 0.5 mm to 5.2 mm long. The smallest juveniles were easily distinguished by

their nearly perfectly round embryonic shell with its very sharp caudal cusp. All specimens were collected singly, except 5 juveniles caught at 34 m in the Antilles Current north of Puerto Rico.

The vertical range of _C. cuspidata_ has yet to be firmly established. Bonnevie (1913) collected it from 50-1250 m in the eastern North Atlantic. Stubbings (1938) found a daytime range in the Arabian Sea from about 400 to 900 m, with a peak abundance at about 500 m. However, Menzies (1958), on the basis of oblique tows in the Mediterranean Sea, concluded that _C. cuspidata_ was most abundant in the upper 100 meters, with none occurring at the surface in the daytime. Wormelle (1962) collected individuals in the Florida Current mostly at night, and found a range from the surface to 362 m. Spoel (1970a) observed in the eastern central Atlantic that _C. cuspidata_ avoided the surface and was not frequently captured in the upper 50 m. In the present study the one adult was collected from 250 m depth during the day. The juveniles were found from 455 to 524 m during the day and from 31-34 m and 423-500 m at night.

On the basis of these and historical data, _C. cuspidata_ appears to be a mesopelagic species showing some evidence of diurnal vertical migration. Juveniles of _C. cuspidata_ occupied temperature ranges of 10.5-12.5°C and salinity ranges of 35.2-35.7‰ during the day and 27.4-28.8°C and 35.75-35.92‰ at night (Figure 25A), while the adult came from water that was 17.5°C and 36.38‰. The only comparable data are those reported by Williams (1972) from the Gulf of Mexico: 12.5 - 19.4°C and 36.04 - 32.25 °/oo.

Clio polita (Pelseneer, 1888)

One adult of this bathypelagic species was collected in the Caribbean west of Dominica Passage at a depth of 1040 m, where the temperature was 5.2°C and the salinity was 34.88‰. It measured 9.8 mm long and 5.0 mm wide, and lacked a shell.

The majority of the records for adults of this species have come from the North Atlantic (10°-70° N) below 1000 m (Tesch, 1946; Spoel 1967). The juveniles have nearly always been collected in the upper 200 meters in the same areas (Tesch, 1946; Wormelle, 1962; Chen and Bé, 1964). The only temperature and salinity data are those of Tesch (1946) of 3.32-6.21°C and 34.50-35.55‰ and Williams (1972) in the Gulf of Mexico at 19°C and 36.25‰.

Genus Cuvierina Boas, 1886

Cuvierina columnella (Rang, 1827)

Figures 25B, 26-29A

Cuvierina columnella Spoel, 1967, pp. 79-81, figs. 41, 74, 75. A complete synonymy.

Creseis caliciformis Meisenheimer, 1905, p. 308, 3 figs.--Tesch, 1913, p. 26, fig. 20.--Chen, 1962, pp. 68, 69, plate XIII, fig. 20.--Myers, 1968, p. 24, plate II, fig. 7.--Hughes, 1968, plate III, figs. 5-7.

Creseis acicula clava (non Rang, 1828) Tokioka, 1955, p. 64, plate IX, figs. 18, 19.

Creseis virgula clava (non Rang, 1828) Chen and Bé, 1964, pp. 191-194, figs. 3c, 4c.--Myers, 1968, p. 23, plate II, fig. 3.--Austin, 1971, pp. 73-74, plate IV, fig. 26.--Williams, 1972, p. 50,

plate II, fig. 8.

Styliola sinecosta Wells, 1974, pp. 293-296, figs. 1-3.

Cuvierina columnella is a cosmopolitan, typically tropical and subtropical species, which occurs in the Atlantic Ocean from 40° S to 50° N and is most numerous in the western North Atlantic (Spoel, 1967). The species includes 3 formae, one of which, C. columnella f. atlantica Spoel, 1970b, is found in the tropical Atlantic.

Generally only individuals possessing the shape of the adult shell have been reported. The embryonic tip and part of the juvenile shell are deciduous and are cast off at an early stage in development. Though a juvenile shell still connected to the adult shell and an embryonic tip were both illustrated as early as 1886 by Boas and later by Frontier (1963a, 1966a), most workers have treated the juvenile shell as one of three species: Creseis caliciformis, Creseis acicula clava or Styliola sinecosta. The present study included a series of individuals of C. columnella ranging in size from an embryonic tip to a complete adult shell with the juvenile shell still attached (Figures 26 and 27). Unfortunately, the complete adult shell broke during the study but the two halves are shown in Figure 27. Figure 26D is the stage in development that has historically been identified as Creseis acicula clava and Figures 27A and 27B are stages that have been referred to as Creseis caliciformis.

Creseis acicula f. clava as described by Rang (1828) is definitely an infraspecific form of C. acicula (vide ante). Tokioka (1955), however, illustrated and described as C. acicula clava two shells that probably were juveniles of Cuvierina columnella. They were 1.5 mm and 1.9 mm long, straight, smooth and conical and tapered from apertures of

0.49 mm and 0.38 mm diameter to constrictions near the posterior end which separated the slightly bulging embryonic tips from the rest of the shells. Both had a length to width ratio of 3.8:1, and the embryonic parts were 0.40 mm long. In contrast, the true *Creseis acicula* f. *clava* has a length to width ratio of about 6:1 and an embryonic shell characterized by two or more swollen transverse rings, no constriction, and straight tapering sides. Tokioka's two specimens agree almost exactly with Figure 26D of *Cuvierina columnella*. The only differences are the height to width ratio of 4.3:1 in Figure 26D compared with Tokioka's 3.8:1 and an embryonic shell length of 0.22 mm versus 0.40 mm.

Chen (1962) reported that specimens of *Creseis clava* which he collected in the western North Atlantic were in reality juveniles of *Creseis caliciformis*. He synonymized *Creseis clava* with *C. caliciformis*. The specimens he described and illustrated conform in every way to the stages of development of *Cuvierina columnella* depicted by Figure 26D and Figure 27B. Chen reported that the species showed diurnal migration and had an optimum daytime depth near Bermuda of 75-100 m. As will be discussed later, this report fits well with the present data on the distribution of juvenile *Cuvierina columnella*.

Chen and Bé (1964), using much of the data from Chen's (1962) work, reinstated *Creseis virgula clava* and did not mention *Creseis caliciformis*. Their illustrations and descriptions of *C. virgula clava* correspond to Figure 26D. They noted that the species exhibited diurnal migration, avoiding the surface waters in the Sargasso Sea during the day.

Three other workers, Myers (1968), Austin (1971), and Williams

(1972), photographically illustrated and described Creseis virgula clava that correspond well to Figure 26D and should be considered as juveniles of Cuvierina columnella. No significant distributional data for clava were presented in these three studies.

Creseis caliciformis was described by Meisenheimer (1905) on the basis of 2 shells, 8 and 10 mm long. He illustrated and described one shell but gave no scale for his drawing. The shells had the appearance of ". . . eines langgestielten Weinglases," with a surface marked only by fine transverse striations. The embryonic shell was " . . . durch eine seichte Furche gegen die übrige Schale abgesetzt, erweitert sich sodann beträchtlich, um sich von neuem einzuschnüren und mit einer stumpfen, bräunlich gefärbten Endspitzen zu enden." Meisenheimer's illustration of the embryonic shell agrees so closely with Figure 26C that the two fit almost exactly when superimposed. Meisenheimer's height to width ratio for the embryonic shell is 3.1:1, compared with 2.6:1 in Figure 26C. The only difference between the two is the lack of a brownish tip in the samples from the Caribbean. Meisenheimer's entire shell, in a similar manner, corresponds closely to Figure 27B.

Spoel (1967) has already suggested that Creseis caliciformis is a juvenile stage of Cuvierina columnella. As proof, he illustrated Meisenheimer's shell joined to an adult of C. columnella f. columnella, showing that they fit well together.

As previously mentioned Chen (1962) identified Creseis caliciformis from the Sargasso Sea. His illustrations and description correspond exactly to Figure 27B. Myers (1968) also collected Creseis caliciformis from the Sargasso Sea. His specimens correspond to Figure 27C. All but one of his specimens were collected in the upper 50 m at

2300 hours. In the Gulf of Mexico, Hughes (1968) collected three specimens of C. caliciformis. He illustrated a dorsal and ventral view of the animal removed from the shell. Distinguishing characteristics such as the slender, straight body shape, lack of wing tentacles, presence of at least 5 bands of cells in the mantle gland, and posterior foot lobe smaller than the wings, identify his specimens as Cuvierina columnella.

Another species that is a juvenile stage of Cuvierina columnella is Styliola sinecosta Wells, 1974, based on 12 immature specimens collected in the upper 300 meters near Barbados. His description of Styliola sinecosta was:

> Shell conical, slightly curved, aperture circular. There is no sculpture on the shell, but faint growth lines can be seen. The posterior embryonic shell is rounded at the posterior tip. The posterior foot lobe is tongue shaped; the relatively small wings are narrow and lack tentacles on the anterior border. A mantle extension, on the left side, the excurrent siphon (formerly known as the 'balancer') is present, and the body is yellowish in freshly preserved material.

All characteristics listed by Wells except the shape of the embryonic shell are the same as Styliola subula, leading Wells to conclude that his new species belonged to the genus Styliola. These characteristics, however, including the embryonic shell shape, correspond to the features of juvenile Cuvierina columnella of which Wells was apparently unaware because he concluded immediately after discussing the genus Creseis that "the only other genus with a conical shell is Styliola, ..." Wells neglected one anatomical aspect of Styliola sinecosta that is not characteristic of Styliola subula. He showed the mantle gland of S. sinecosta covering at least half of the visceral mass as it does in both the juvenile and adults of Cuvierina

columnella. On the other hand, the structure in S. subula covers distinctly less than half, usually about one fourth, of the visceral mass.

The sizes of Wells' specimens and the juveniles of Cuvierina columnella collected in the present study compare favorably, with length to width ratios of 3.2:1 to 4.13:1 and 2.6:1 to 4.3:1, respectively. The embryonic shells of Styliola sinecosta measured 0.35-0.42 mm long and 0.12-0.18 mm wide. The embryonic shells of Cuvierina columnella were 0.20-0.42 mm long and 0.07-0.20 mm wide. The greater ranges in measurements for C. columnella can be accounted for by the 500 specimens available in this study compared with the 12 specimens used by Wells.

To verify the conclusions regarding S. sinecosta Wells, six paratypes were obtained on loan from the National Museum of Canada, Ottawa, Ontario. Upon receipt of the specimens, it was discovered that although they had been preserved for no more than 21 months, all shells had undergone complete dissolution. A comparison of these specimens was made with juveniles of Cuvierina columnella that were at about the same stage of development and had been partially removed from their shells (Figure 28). The specimens were identical in every aspect. Each was characterized by a slender, tapering body, at least 4 zones of cells in the mantle gland, the mantle gland covering about two-thirds of the visceral mass, a lack of tentacles on the wings, and a tongue-shaped posterior foot lobe. The "balancer" mentioned by Wells was visible as a slight folding in the mantle edge on the left side. A "balancer" has been previously reported on the left side for the adults of Cuvierina columnella by Tesch (1904).

Finally, it should be noted that Bé, MacClintock, and Currie (1972) illustrated an embryonic shell of C. columnella which bulged prominently and possessed a distinct cusp at the posterior tip. This shell resembles none of the Caribbean specimens nor those described from other areas.

In the present study C. columnella comprised 0.4% of the thecosomes and of these 92.6% were juveniles. Those in the "minute" stage of development constituted 4.8% of the total juveniles. Wells (1973), near Barbados, collected juveniles of C. columnella (Styliola sinecosta) at an average density of 0.8 individuals/1000 m^3 of water (less than 0.1% of the total euthecosomes). In the same location over a two-year period, Wells (1974) reported an average abundance of 2.2 individuals per 1000 m^3 of water.

The horizontal distribution of this species was uniform throughout the Caribbean except for two areas of high abundance of juveniles just inside the Windward Passage.

This species has been noted by most authors as a strong vertical migrator. In the Florida Current, Wormelle (1962) collected very few in the daytime but found higher numbers at night, with a maximum between 50 and 200 m. Lewis and Fish (1969) collected this species near Barbados at the surface only at night. Chen and Bé (1964) and Myers (1968) reported similar results in the Sargasso Sea, capturing adults in the surface waters only at night. Spoel (1973) observed that in the Sargasso Sea the depth range of vertical migration was 140 m, and that 96% of the individuals crossed the average depth level from day to night.

In this study C. columnella exhibited a marked vertical migration.

The adults were collected at between 224 and 344 m during the day and entirely in the upper 65 m at night. The juveniles were captured from 30-290 m during the day with an average depth of 53 m. There was evidence of size segregation with depth, since 11 of the 15 juveniles collected below 100 m were larger than 2.0 mm long. At night the entire juvenile population occurred in the upper 75 m with an average depth of 48 m. No juveniles were captured at the surface during the day while 12.6% of the nighttime population was captured there.

The strong migratory tendencies of this species are evidenced also in its diel differences in temperature and salinity ranges. During the day the adults occupied 14-19°C and 35.4-36.3‰ water and at night 27-28.5°C and 35.4-36.3‰ (Figure 25B). The juveniles during the day had two separate populations with mostly small individuals at 25.5-28°C and 35.4-36.3‰ and large individuals at 14-19°C and 35.7-36.6‰ (Figure 29A). At night only one group was present at 26-29°C and 35.6-36.3‰. The only comparative data are Williams (1972) collections in the Gulf of Mexico at the surface from 25.5°C and 36.18‰.

Genus Diacria Gray, 1847

Diacria trispinosa (Blainville, 1821)

Figures 29B-33B

This species is widely distributed over the Atlantic from 40°S to 70°N but shows a preference for tropical waters. Two formae have been described, forma trispinosa (Blainville, 1821) and forma major (Boas, 1886).* In the tropical Atlantic both formae occur together with

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*Spoel (1973) has raised these formae to species level with explanations to follow in a paper in preparation.

f. trispinosa usually numerically dominant.

In the Caribbean D. trispinosa represented 0.9% of the total thecosome population. Approximately 88% of the specimens were juveniles. Of those that could be identified to forma, 86 were f. trispinosa and 1 was the forma major. Within the forma trispinosa, 14 individuals were in the minute stage of development. In other Caribbean collections, Wells (1973) captured D. trispinosa (forma not specified) at an average density of 12.5 individuals per 1000 m^3 of water (0.7% of the euthecosomes collected). D. trispinosa ranged from 0.26 mm to 7.0 mm long (exclusive of the caudal spine) and attained a maximum width of 7.2 mm. An embryonic shell 0.26 mm long is illustrated in Figure 30A. It can be readily distinguished from other juvenile Cavoliniidae by its nearly spherical shape and lack of a cusp at its posterior tip.

The horizontal distribution of D. trispinosa is depicted in Figures 31 and 32. The juveniles and especially the adults are more common in the tropical water entering the eastern Caribbean than in the subtropical Sargasso Sea water entering through the Windward Passage.

Wormelle (1962) reported a mean day level of about 219 m in the Florida Current and found indications of a diurnal migration. Spoel (1973) found in the Sargasso Sea that the forma trispinosa migrated over a depth range of 157 m with 94% of its individuals crossing the average depth level from day to night. Myers (1968), also working in the Sargasso Sea, reported juveniles randomly distributed in the upper 125 m during the day with none at the surface at midday. He collected only 6 adults, all at night below 50 meters.

In this study 8.7% of the adults were found from 55-90 meters during the day while the remainder were distributed from 225-344 m with

an average depth of 250 m. At night the population occurred from 45-81 m with an average depth of 50 m. During the day the juveniles were found from the surface (1.1%) to 524 m, with 17.5% in the upper 90 m and an average depth of 250 m. At night the range extended from the surface (1.6%) to 590 m with 74.8% in the upper 81 m and an average depth of 56 m. At night most juveniles in the upper 90 meters measured more than 2.0 mm long indicating that the small juveniles undergo very little vertical migration.

This conclusion is supported by the T-S-P diagrams for the juveniles (Figures 33A and B) which show that they have roughly the same total temperature and salinity ranges during the night and day, with nocturnal increases in abundance in the Tropical Surface Water. The juvenile daytime ranges were 11-28.5°C and 34.0-36.8‰ and night-time ranges were 8-28.5°C and 34.8-36.7‰. The adults showed a much different picture because of their marked vertical migration (Figure 29B). During the day their preferred ranges were 14-18°C and 35.7-36.5‰ while at night their ranges were 26-28°C and 35.3-36.3‰. In comparison Williams (1972) in the Gulf of Mexico observed ranges of 9.1-28.0°C and 34.98-36.68‰.

The one individual of f. major was collected from 274 meters during the day west of the Dominica Passage at a temperature of 14.4°C and a salinity of 35.83‰.

Diacria quadridentata (Blainville, 1821)

Figures 21D, 30B, 30C, 34A

D. quadridentata is a cosmopolitan tropical and subtropical species with a distribution in the Atlantic Ocean between 30°S and 45°N. It

contains two subspecies, _erythra_, with two formae and _quadridentata_, with four formae, three of which --_quadridentata_ (Blainville, 1821), _costata_ (Pfeffer, 1879), and _danae_ Spoel, 1968--occur in the tropical Atlantic (Spoel, 1971a).

Little information is available on the distribution of these three formae. _D. quadridentata_ is rather scarce in the Atlantic. In the Caribbean Wells collected this species (no forma identified) at a maximum abundance of 0.4 individuals/1000 m^3 of water in July near Barbados. In the present study _D. quadridentata_ made up 0.2% of the thecosomes collected, and 42.5% of these were juveniles. The juveniles ranged from 0.2 mm to 1.8 mm long and 0.7 mm wide. The adults did not exceed 1.8 mm long (excluding the caudal spine) and 1.5 mm wide.

The only forma present in these collections was _D. quadridentata_ f. _danae_, with shell lengths from 1.2 to 1.8 mm. About 28% were in the minute stage of development. Photographic illustrations of juvenile _D. quadridentata_ are provided in Figures 30B and C.

The horizontal distribution of the adults of _D. quadridentata_ showed very low abundance through the entire central Caribbean and relatively greater abundance associated with the land masses in the south and along the island chain in the north and the east. The horizontal distribution of the juveniles was fairly uniform.

Previous records indicate that _D. quadridentata_ migrates vertically. Stubbings (1938), on the basis of a collection of 23 juveniles and 11 adults in the Arabian Sea, suggested that this species appeared near the surface at dawn and twilight and sank to deeper layers during the day and at night. On the west side of the Florida Current, Wormelle (1962) observed mean day levels of 169 and 99 m and a mean night level

of 134 m, while on the east side, she found a mean day level of 214 m and a mean night level of 163 m. Wormelle observed no significant difference in vertical distributions between adults and juveniles. Myers (1968), however, found no evidence of migration, with most specimens collected from depths of 20 to 60 m in the Sargasso Sea.

In this study the adults evidenced only a slight migration. The daytime distribution was from 30-125 m (average depth, 50 m) and at night, from 0-65 m (average depth, 0 m). The juveniles showed a wider vertical distribution and a slight upward movement at night. Their daytime range was 50-261 m (average 160 m), and their nighttime range was from 0-258 m (average 65 m).

The reports of the various authors regarding the bathymetric distribution of this species do not agree with each other or with the present data. These differences could be due to geographical variations or the result of the collection of different formae.

In the Caribbean during the day, adults of D. quadridentata occupied the high salinity areas of the Tropical Surface Water and the core of the Subtropical Underwater. The ranges involved were 22-28°C and 35.75-36.7‰ (Figure 21D). At night the adults were restricted to the surface waters, 27-28.5°C and 35.4-36.25‰, with one specimen collected from 29.3°C and 34.27‰. The juveniles showed much wider ranges, being collected in water from 18-28°C and 35.9-36.7‰ during the day and in two groups, 18.5-20°C and 36.5-36.7‰ and 27-28°C and 35.4-36.3‰, at night (Figure 34A). The only other available data are from Williams' (1972) report from the Gulf of Mexico, showing total ranges of 19.0-25.5°C and 35.70-36.25‰.

Genus Cavolinia Abilgaard, 1791

Cavolinia longirostris (Blainville, 1821)

Figures 34B, 34C, 35A

C. longirostris is a very common species in the Atlantic, occurring from 50° N to 45° S but most abundant in the tropics. Tesch (1946) found the greatest numbers of this species in western tropical Atlantic waters from 0-20° N and 40° W-80° W, as did Lewis and Fish (1969) in this area, near Barbados. They reported that C. longirostris was the most abundant species of euthecosome, with peaks in the spring and summer over a two-year period. However, Wells (1973), working in the same area, collected small numbers of C. longirostris in the summer (July), with an average density of 3.1 individuals per 1000 m^3 of water, less than 0.2% of the euthecosomes he collected.

Five formae of this species have been described. Though distributional data at the forma level are scarce, three of the formae, longirostris (Blainville, 1821), limbata (d'Orbigny, 1836), and strangulata (Deshayes, 1823), have been collected in the tropical and subtropical Atlantic (Spoel, 1970a). In the present study these three were identified, with the forma longirostris by far the most abundant. Differentiation at the forma level was possible only for the fully shelled minute stage and adults.*

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*Identification of juveniles was at times difficult, especially for the very small individuals of C. longirostris, which closely resembled the juveniles of C. inflexa. Troost and Spoel (1972) used differences in the two such as caudal spine lengths and the appearance of the lateral appendages. Caudal spine length, however, proved to be useless as a differentiating characteristic below a size of 1.00 mm because at that size the spine lengths were nearly identical. Appearance of the lateral appendages was a valuable tool for specimens as small as 0.6-0.7 mm shell length. Smaller specimens could only be examined under high magnifications, a lengthy procedure. Thus all Cavolinia juveniles smaller than 0.6-0.7 mm shell length were classified only as Cavolinia sp.

C. longirostris comprised 1.2% of the thecosomes collected in this study, and of these 55.6% were juveniles. The specimens ranged from 0.5 mm to 3.0 mm long and 2.7 mm wide (strangulata), 3.2 mm and 2.9 mm (longirostris), and 6.9 mm and 5.4 mm (limbata). The three formae were collected at a ratio of 40 longirostris : 5 strangulata : 1 limbata. Approximately 4% of the individuals of forma longirostris were in the minute stage of development.

The horizontal distribution of adults of C. longirostris was very patchy and could not be interpreted. The juveniles showed peaks in abundance in the Antilles Current north of Puerto Rico, south of Hispaniola, and along the coast of the Yucatan Peninsula. At the forma level, longirostris and strangulata occurred together in the same sample, as did longirostris and limbata. The adults of longirostris and strangulata had patchy distributions similar to the overall distribution of C. longirostris. The forma limbata was collected only between Grenada and Tobago and near St. Andrews Island.

Only very limited vertical migrations have been reported for this species. Wormelle (1962) observed mean day levels of 215 and 35 m and a mean night level of 76 m on the west side of the Florida Current, and on the east side, a mean day level of 118 m and a mean night level of 42 m. Myers (1968) collected individuals only in the upper 75 m of the Sargasso Sea and found a slight downward migration during the day.

In the present study, individuals of C. longirostris f. longirostris were collected from the surface (16.7%) to 62 m during the day, with one individual taken from 224 m. At night the distribution was from the surface to 52 m, with 93.6% of the individuals at the surface. One specimen of the forma strangulata was captured at 52 m in the

daytime and 27 specimens were collected at the surface at night. All of the forma limbata were collected at night, one at the surface and 6 at 30 m. At the species level, juveniles were distributed from the surface to 275 m during the day (average depth 50 m) and from the surface to 1000 m at night (average depth 34 m). A slight upward migration to the surface was indicated, with 5.9% at the surface in the daytime and 39.5% at night.

The three formae of *C. longirostris* were found almost exclusively in Tropical Surface Water. The adults of f. *longirostris* (Figure 34B) occurred during the day, within a range of 23.5-28°C and 34.4-36.7‰. At night the ranges were slightly altered toward warmer, less saline water of 27-29°C and 34.3-36.1‰, with two individuals occurring at 28.8°C and 32.71‰. The adults of f. *strangulata* showed a similar nighttime range of 26-29°C and 34.9-36.4‰, with 7 individuals at 28.8°C and 32.71‰. The forma *limbata* had one individual from 29.1°C and 36.04‰ and 6 individuals from 26.6°C and 35.98‰. The juveniles had greater total ranges than the adults. Their optimum ranges, 25.5-28°C and 35.7-36.4‰, during the day (Figure 35A) and 26-29°C and 34.25-36.2‰ at night (Figure 34C), were very similar to the adults' total ranges. In comparison, Williams (1972) found greater temperature (16.2-28.6°C) and lesser salinity ranges (35.03-36.33‰) in the Gulf of Mexico.

Cavolinia uncinata (Rang, 1829)

Figure 35B

This species is most abundant in tropical waters but also occurs in subtropical areas. Its range in the Atlantic is from 45° N to 45° S, with its greatest recorded abundance from 15° N just off the west coast

of Africa (Tesch, 1946). In the Caribbean, Tesch (1946) reported upon 202 individuals at 50 m and 282 individuals at 100 m in 4 hours of towing between St. Croix and St. Thomas. Lewis and Fish (1969) and Wells (1973) collected none during 2 year studies in the Caribbean near Barbados.

In the present study, 39 adults and 4 specimens in the minute stage of C. uncinata were collected. They were distributed sporadically throughout the collections from the Caribbean. The adults' maximum size was 6.7 mm long and 5.2 mm wide. Of the five known forma, only one, forma uncinata (Rang, 1829), could be identified.

The vertical distribution, though based on only a few specimens, showed a pattern of vertical migration. During the day the adults were found from 59 to 250 m. At night their occurrence was from the surface to 132 m with 1 specimen from 635 m.

Evidence of vertical migration can also be seen in the temperature and salinity ranges occupied by the adults (Figure 35B). During the day the adults were found in waters of 14-27°C and 35.7-36.75‰. At night the ranges were 27-29°C and 35.6-36.3‰, with one specimen from 18.8°C and 36.51‰. In the Gulf of Mexico, Williams (1972) found ranges of 17.4-23.1°C and 36.01-36.13‰.

Cavolinia gibbosa (d'Orbigny, 1836)

One shell-less adult of this species was collected at a depth of 50 m during the day in the central Caribbean. The water temperature was 27.5°C and the salinity, 36.16‰. C. gibbosa is a rare species that has been reported from 45° N to 35° S in the Atlantic, with its greatest abundance north of 10° N and south of 15° S (Spoel, 1967).

Only one forma, flava (d'Orbigny, 1836), has been reported from the tropical Atlantic.

The vertical distribution of this species has been recorded by Menzies (1958), who found all individuals in the upper 100 m, and Spoel (1973), who found the majority in the upper 200 m. Spoel's report also showed little evidence for vertical migration with average day and night levels differing by only a few meters. The only environmental data reported on *C. gibbosa* are Williams' (1972) temperature and salinity ranges of 24.5-25.5°C and 35.70-35.86‰ in the Gulf of Mexico.

Cavolina inflexa (Lesueur, 1813)

Figures 36-38B

C. inflexa occurs throughout the Atlantic from 55° N to 45°S and is the most common species of *Cavolinia* in most of that area. Three forma of this species are known, all of which occur in the Atlantic. The forma *imitans* (Pfeffer, 1880) occupies mainly the tropics, the forma *labiata* (d'Orbigny, 1836) shows a bisubtropical distribution, and the forma *inflexa* (Lesueur, 1813) appears equally abundant over the entire range of the species (Spoel, 1967, 1970a).

In the Caribbean Tesch (1946) reported catches of 500 individuals in 2 hours of towing at 100 m at 14°21'N and 76°50'W; 500 individuals in 2 hours towing at the surface just west of Dominica; and 250 individuals from a 2 hour tow at 100 m west of St. Croix. Wells (1973) collected an average density of 6.9 individuals/1000 m^3 of water (0.4% of the total euthecosomes) near Barbados in July. A total of 225 adults and 185 juveniles were collected in this study making up 0.3% of the thecosome population. The specimens measured 0.7 mm to 4.7 mm long

and 2.9 mm in maximum width. Juveniles smaller than 0.6-0.7 mm shell length could not be identified to species. The only forma collected in this study was inflexa.

The horizontal distribution of the adults of C. inflexa (Figure 36) showed areas of abundance associated with the island arc in the southeast. Low numbers were found in the Windward Passage, indicating a preference by the adults for tropical waters as compared to the more subtropical Sargasso Sea waters. In contrast, the juveniles (Figure 37), were equally abundant in waters entering from the southeast and waters entering through the Windward Passage.

Marked vertical migrations have not been reported for this species. Although Wormelle (1962) stated that evidence of diurnal migration in the Florida Current existed, she listed a mean day level of 88 m and a mean night level of 98 m on the west side of the current and a mean day level of 178 and night level of 164 m on the east side. The present data, in contrast, suggest a strong vertical migration. During the day, adults were collected from 50-550 m with an average depth of 261 m, and at night they spread from 56 m to the surface (average depth 50 m), with one individual collected at 250 m. The juveniles showed nearly an identical distribution, with a range of 21-500 m (average 243 m) during the day and 0-75 m (average 50 m) at night.

The strong migratory pattern is also reflected in the temperature and salinity ranges of the waters occupied by this species. During the day most adults had ranges of 14-19°C and 35.7-36.6‰ contrasted to 27-29°C and 35.4-36.1‰ at night (Figure 38A). The juveniles had slightly wider ranges: 14-28°C and 35.7-36.75‰ during the day and 26-29°C and 34.3-36.3‰ at night (Figure 38B). In comparison, Chen and Bé (1964)

reported a temperature range of 16.8-27.9°C and a salinity range of 35.5-36.7‰. Williams (1972) observed total ranges of 14.8-28.5°C and 34.95-36.51‰.

Genus Peraclis Forbes, 1844

Peraclis reticulata (d'Orbigny, 1836)

P. reticulata, the most common species of Peraclis, is encountered throughout the tropical and subtropical waters of the Atlantic, though always in small numbers. Twenty-five individuals of this species were collected in the present study. They ranged from 0.5 mm to 2.3 mm high and 1.7 mm wide. Most specimens less than 0.8 mm high could not be identified to species because the distinguishing characteristics at the species level apply only to large juveniles and adults.

P. reticulata was scattered horizontally throughout the Caribbean. A daytime range of 50-233 m, a nighttime range of 48-65 m, and a total range of 25-239 m (including twilight periods) were recorded. In comparison, Bonnevie (1913) in the North Atlantic observed a depth range of 50-250 m and Tesch (1946) reported specimens from the upper 50 m to 2500 m, with maximum abundance at about 200 m. Myers (1968) found this species absent from the upper 150 m at night and present at 75-100 m during the day in the Sargasso Sea.

The water which P. reticulata occupied had temperatures of 18.5-22.5°C and salinities of 36.25-36.9‰. The only other record on environmental conditions during collection was by Williams (1972) who reported this species at 24.9°C and 35.8‰ in an area of upwelling in the Gulf of Mexico.

Peraclis bispinosa Pelseneer, 1888

Figure 39A

Thirty-three individuals of this deep-living species were collected. The individuals measured 0.5 mm to 5.8 mm high. As would be expected of a species living in deeper waters, P. bispinosa has a wide geographic range, occurring over nearly the entire Atlantic at depths of 100-1500 m in the North Atlantic (Bonnevie, 1913) and 500-2500 m in both the North and South Atlantic (Tesch, 1946). Chen (1962) reported an optimum depth of 200 m in the Sargasso Sea. In the same area, Myers (1968) found this species present at 150 m during the day and night. In this study P. bispinosa had a total vertical range of 65 to 4105 m. The daytime distribution was 100-410 m (one individual at 4105 m) and the nighttime levels were 65 to 258 m.

The T-S-P diagram (Figure 39A) shows virtually the same distributions during the day and night, with a concentration at night from 17.5-18.5°C and 36.5-36.7‰. The total ranges of temperature and salinity were 6-22.5°C and 34.7-36.7‰. Tesch (1946) reported its ranges in the Atlantic as 3.24-11.64°C and 34.82-35.57‰.

Peraclis moluccensis Tesch, 1913

Five specimens of this species were collected in the Caribbean. They measured 0.4 mm to 1.7 mm in height. One specimen was collected at 224 m during the day (19.1°C and 36.64‰); one from 240 m near sunset (15.1°C and 35.99‰); and three from 250 at night (18.2°C and 36.54‰).

This species has been collected very rarely in the Atlantic, though Tesch (1946) cited it as one of the most common species of

Peraclis there. Tesch reported a depth range of 300-2500 m with accompanying temperature and salinity ranges of 3.40-7.99°C and 34.81-35.39‰. Chen (1962) observed juveniles at depths of 300 to 500 m in the Sargasso Sea in the summer and near the surface during the winter.

Austin (1971) and Williams (1972), both working in the Gulf of Mexico, reported specimens as *P. triacantha* that were in all probability *P. moluccensis*. Though they provided no descriptions, their photographic illustrations both showed shells with the apex projecting slightly above the top of the rounded aperture in profile view as in *P. moluccensis*. In contrast, the apex of *P. triacantha* does not project above the top of the aperture in profile view (often the apex is depressed) and the aperture is more square than rounded. Austin (1971) reported collecting his specimens at depths of from 55 to 120 m, with several collections at temperatures of 18-21°C and a salinity of 36.0‰. Williams' (1972) specimens came from 100-300 m at a temperature range of 9.8-25.5°C and a salinity range of 35.14-36.28‰.

Peraclis triacantha (Fischer, 1882)

P. triacantha was one of the most common species of *Peraclis* reported by Tesch (1946) in the Atlantic. Tesch (1946) characterized its vertical distribution as being very similar to that of *P. reticulata*, ranging from the upper 50 m to 3000 m with the greatest numbers around 200 m. In the only Caribbean record, Cervigon and Marcano (1965) reported it from 250-300 m during the day in the Cariaco Trench.

In the present study 6 individuals measuring 0.8 mm to 2.3 mm high and 2.8 mm wide were collected from 125, 234, 238, 455 and 500 m west

of 69° W. The temperature and salinity ranges were 12.5-21°C and 35.7-36.6‰.

Peraclis apicifulva Meisenheimer, 1906

Figure 39B

This species was depicted as the rarest of the genus *Peraclis* throughout the Atlantic by Tesch (1946); but it was by far the most abundant in the present study. Fifty-seven specimens, ranging from 0.4-3.1 mm long, were collected between 21 and 470 m. Daytime ranges were 160-470 m (one individual at 21 m) and nighttime ranges were 218-265 m. Their average day level and night level were identical, indicating that little diurnal migration took place. Chen (1962) found a similar vertical distribution in the Sargasso Sea, where the greatest numbers occurred from 100 to 300 m, with a total range of 0-400 m. Tesch (1946) reported a range of 50-2500 m, with the greatest abundance near 200 m.

The T-S-P diagram (Figure 39B) indicates a preference for waters from 14.5-20°C and 35.7-36.7‰. One specimen (3.1 mm high) was collected in the tropical surface waters at a temperature of 26.7°C and a salinity of 35.97‰.

Genus *Cymbulia* Péron and Lesueur, 1810

Cymbulia sp.

Figures 34D, 40A

Representatives of this genus are cosmopolitan in the Atlantic Ocean and occur from 50° N to 40° S. Three species have been reported from the tropical Atlantic. As pointed out by Tesch (1946), however, the animals of the three species are identical and the pseudoconchs differ by only a few minor features. The first species described,

C. peroni Blainville, 1818 was based on specimens that had pseudoconchs with a blunt dorsal end, sinuous rows of denticles on the aboral surface, and uninterrupted tapering sides. A second species, C. parvidentata Pelseneer, 1888, differs from C. peroni mainly in having a constriction at the middle of its length. This constriction, as discussed by Tesch (1946), could have been caused by the action of the preservative. The third species, C. sibogae Tesch, 1903, differs from C. peroni by having a very pointed dorsal end and a smaller size. Massy (1909), however, collected specimens of C. peroni that had pointed dorsal ends the same as C. sibogae.

The specimens collected in the present study were all detached from their pseudoconchs. The shell-less animals comprised 0.2% of the thecosomes collected and ranged in size from 0.8 to 11.5 mm wide across the wings. Sixteen pseudoconchs were collected, all small (12.3-17.3 mm long) and acutely pointed at the dorsal end.

Wormelle (1962) reported C. peroni from the Florida Current at depths from 10 to 700 m. Rampal (1967), in contrast cited C. peroni as a bathypelagic species with its maximum abundance between 1000 and 2000 m. In the Caribbean material, Cymbulia sp. had a vertical distribution during the day of 30 to 445 m (average depth 233 m) with 35.8% in the upper 90 m. At night the population had migrated up and occurred from the surface to 75 m (average depth 34 m).

The T-S-P diagrams (Figures 34D and 40A) reflect the pronounced migration. During the day the individuals were distributed in waters characterized by 13.5-28°C temperature and 35.7-36.7‰ salinity. At night the entire population was located in the Tropical Surface Water, with temperatures of 26-29°C and salinities of 35.3-36.3‰.

The only other data reported are Rampal's (1967), from the Mediterranean, of 13.04-13.30°C and 38.50‰.

Genus _Gleba_ Forskål, 1776

Gleba cordata Forskål, 1776

This species is extremely rare in the Atlantic and occurs in moderate numbers only in the Mediterranean Sea and the Florida Current. Tesch (1946) reported only 2 specimens in the entire collections of the "Dana" expeditions, both from the Sargasso Sea at 200 and 400 m. Gilmer (1972), while scuba diving, observed over 500 of this species and _Corolla spectabilis_ in the surface waters of the Florida Current over a 2-month period.

In the present study, 12 individuals without pseudoconchs and one empty pseudoconch were collected between 45 and 125 m at ranges of 21-29°C and 35.3-36.9‰ south of Hispaniola and Puerto Rico.

Genus _Corolla_ Dall, 1871

Corolla spp. (?)

Figure 41

Three species, _C. spectabilis_ Dall, 1871, _C. calceola_ (Verrill, 1880), and _C. intermedia_ (Tesch, 1903), have been reported from the tropical Atlantic. Positive identification utilizes the relationships of the body to its pseudoconch, in particular the distance the wing extends beyond the pseudoconch and the shape of the pallial gland. Unfortunately, all animals collected in this study and the majority collected by previous workers were separated from their pseudoconchs, rendering specific identification impossible.

Five empty pseudoconchs were found in the Caribbean material, four of which had tubercles irregularly spaced on the pseudoconch, tentatively indicating that they belonged to C. spectabilis or C. intermedia. The remaining pseudoconch had regularly spaced tubercles, tentatively relegating it to C. calceola.

Eighty animals of Corolla were collected from depths of between 25 and 75 m. The specimens ranged in size from 0.6 to 12.3 mm across the wings. The horizontal distribution (Figure 41) shows a preference for tropical waters since the highest numbers occurred in the southeast and no specimens were collected in the Windward Passage. No differences in vertical distribution were observed in day and night collections. The temperature and salinity ranges occupied by Corolla were 26.5-29°C and 34.3-36.3‰.

In one of the few studies on vertical distribution for this genus, Wormelle (1962) observed a mean day level of 221 m and a mean night level of 52 m for C. spectabilis on the west side of the Florida Current. Wormelle also collected C. calceola in the Florida Current during the day from 120 m. Gilmer (1972) found C. spectabilis in the surface waters during October and November in the Florida Current.

Genus Desmopterus Chun, 1889

Desmopterus papilio Chun, 1889

Figures 40B, 42, 43A

D. papilio occurs from 50° N to 40° S in the Atlantic and is a relatively common species in the tropics. Two other species of Desmopterus have been reported from the Atlantic, D. pacificus Essenberg, 1919 and D. gardineri Tesch, 1910. D. gardineri will be

discussed in the next section. *D. pacificus* should be regarded as a synonym of *D. papilio* on the basis of the material collected in the Caribbean. *D. pacificus* as described by Essenberg (1919) differs from *D. papilio* in only 3 characters: it has short spade-shaped tentacles, in contrast to long whip-like tentacles in *D. papilio*, proportionally shorter wings, and the head not bent into the ventral plane as in *D. papilio*.

Spoel (1970a) pointed out the similarity between the two species and discussed possible intermediates. The Caribbean collections provided numerous intermediates. Individuals were collected with tentacles ranging from short, almost non-existent stubs to medium sized ones (0.3 mm long). The tentacles seemed to be fragile and could conceivably break off with rough handling. In fact, several specimens had one medium sized tentacle and one short stub. The heads of the specimens ranged from being bent sharply ventrally to being straight with no bending. The third characteristic, proportion of the wings, is probably not a valid distinguishing character. The two illustrations shown by Essenberg (1919), supposedly depicting the difference in proportion, depict the wings of *D. papilio* with a length to width ratio of 2.97:1 and *D. pacificus* with a ratio of 2.80:1.

D. papilio has been reported previously from the Caribbean by Cervigón and Marcano (1965) from a depth of 250-300 m in the Cariaco Trench. In the present study 219 specimens, comprising 0.2% of the thecosome population, were collected. The specimens ranged from 1.3 mm to 3.4 mm width across the wings.

The horizontal distribution of this species (Figure 42) showed high abundance associated with the tropical waters entering in the southeast

and lower numbers in the subtropical Sargasso Sea waters entering through the Windward Passage. Relatively large numbers also occurred in neritic waters along the coast of Panama in the Gulf of Darien and Mosquito Gulf and off British Honduras.

A very uniform vertical distribution from 50-470 m was found during the day. At night fewer specimens were collected but the distribution was approximately the same, 25-524 m. It apparently lives much deeper in the Sargasso Sea, where Deevey and Brooks (1971) collected specimens from 500-1000 m during July to January.

Due to its lack of vertical migration, the temperature and salinity ranges for this species were almost identical during the day and night: 13.5-27°C and 35.8-36.8‰ in the daytime (Figure 40B), and 13.5-28.5°C and 35.6-36.7‰ at night (Figure 43A).

<u>Desmopterus gardineri</u> Tesch, 1910

This rare species was first described by Tesch (1910) with the diagnostic characteristic being the musculature in the wings composed of wide bands running in two main directions at right angles to each other. In comparison the musculature in the wings of <u>D. papilio</u> is fairly uniform and shows no conspicuous banding. Spoel (1970a) believed that the bands in <u>D. gardineri</u> might be a result of contraction during fixation. Frontier (1973a) disputed this, stating: "Toutefois l'examen d'un material assez frais nous a permis de constater que le caractère est reconnaissable après un temps très court de fixation. Les mêmes récoltes contenaient d'ailleurs des <u>Desmopterus papilio</u> et des <u>Desmopterus gardineri</u>, sans aucune forme intermediaire." The 14 individuals collected from the Caribbean showed distinct banding, with

no intermediates between them and D. papilio. The specimens ranged in size from 1.3 to 1.6 mm across the wings.

This species was found only at a depth range of 250-500 m in the Subtropical Underwater and was not spread into the surface waters as was D. papilio. The temperature and salinity ranges were 13.5-16.5°C and 35.7-36.25‰. The only other Atlantic record of D. gardineri was Wormelle's (1962) report of one individual from 184 m in the Florida Current.

DISCUSSION

Data from the 49 stations selected for this study were collected over a three year period during the winter and spring months from late October to late April. The temperatures and salinities at the depths of sampling were plotted in a T/S diagram (Figure 44). These data agree well with previous records for the winter months in the Caribbean, for example those of Sturges (1965).

Four water masses can be distinguished on the basis of the temperature and salinity data (Figure 44): the Tropical Surface Water (TSW), the Subtropical Underwater (SUW), the Subantarctic Intermediate Water (SAIW), and traces of the North Atlantic Deep Water (NADW). The Tropical Surface Water is characterized by temperatures greater than 26-27°C and salinities below 36.25-36.50‰, the extremes being 32.71‰ and 29.3°C. The Subtropical Underwater is distinguished by salinities greater than 36.25-36.50‰, with an extreme of 36.97‰ and temperatures from 10 to 27°C. The core of the Subantarctic Intermediate Water can be recognized by a deep water salinity minimum. The intermediate water ranged from 34.69 to 35.12‰ and 5.0-5.5 to 8°C. The presence of the fourth water mass, the North Atlantic Deep Water, is indicated by temperatures less than 5.0°C and salinities from 34.89 to 35.03‰.

Wüst (1964), as discussed in Part I of this work, has shown that the Tropical Surface Water, but not the deeper water masses, undergo fluctuations in temperature and salinity from the hot, wet season (June to November) to the cooler, dry season (December to May). These seasonal fluctuations should have minimal effect on the present study, however, since nearly all of the samples were collected in the same

season. In addition, annual variations in environmental conditions which play a large part in affecting zooplankton abundance in other areas, have only a small effect in the Caribbean (Lewis et al., 1962; Lewis and Fish, 1969; Steven, 1971) and are of little import for this study.

To estimate thecosome production in the Caribbean, the total number of specimens from all depths was plotted for each station (Figure 45). There is relatively uniform distribution throughout the Caribbean except for regions of low abundance extending from the Yucatan Channel through the central areas to approximately the middle of the Lesser Antilles (15° N). Available historical data support this distributional pattern. Steeman Nielsen and Jensen (1957), Beers et al. (1968), Björnberg (1971), Margalef (1971) and Steven (1971) cite the central Caribbean as an area low in nutrient concentrations and low in primary and secondary production.

Logically, areas of high production should be associated with waters of high nutrient concentrations such as upwelling areas. The two stations with the highest thecosome abundance (P-6811, stations 4 and 7) were located in the cyclonic gyre in the southwest and were associated with upwelling areas. This gyre is fed by waters from the upwelling regions along the coasts of Panama and Costa Rica and the coasts of Venezuela and Colombia (Bogdanov, 1965; Rossov, 1966; Gordon, 1967; Perlroth, 1971). The high abundance did not occur at the immediate sites of the upwelling, but at a distance downstream because of the lag at which zooplanktonic production follows upwelling (Margalef, 1971). In fact, an examination of the two stations with the strongest upwelling (P-6701, station 20 and P-6811, station 9) showed very low thecosome abundance.

Since over 95% of the total number collected occurred in the upper 200 m, the strong upwelling at these two stations displaced most of the shallow water that the thecosomes normally would occupy.

The pattern of distribution of total thecosomes (Figure 45) is nearly identical with that of the juveniles euthecosomes, which constituted 91.5% of the total (Figure 46). This very high percentage of juveniles indicates that reproduction was prevalent throughout the Caribbean at least from October through April and probably year-round. Owre and Foyo (1964, 1972) have previously commented on reproduction in the Caribbean, noting high numbers of juvenile copepods in the eastern areas and the Yucatan Channel. They suggested that the eastern Caribbean and other parts of the Sea were "nursery" areas for many holoplanktonic forms.

Comparison of total juveniles with other studies on distribution of thecosomes is virtually impossible since most other workers used large-meshed nets and did not separate adults from juveniles. The only comparable works are those of Myers (1968) in the Sargasso Sea, in which nets with a mesh size of 0.203 mm were used, and Wells' (1973) collections off Barbados, made with a net of 76 microns mesh size. Myers reported that 64.2% of the individuals of *Limacina inflata*, *L. trochiformis*, *Creseis acicula*, and *Styliola subula* were juveniles. Wells found that 94.9% of the *L. inflata* were juveniles.

The adult euthecosome distribution (Figure 47) was very uniform except at four stations with low numbers (less than 32 specimens). One station was located south of Hispaniola, one was in the Grenada Passage, and two coincided with upwelling areas near the coasts of Venezuela and Colombia.

The pseudothecosome distribution (Figure 48) was characterized by generally low abundance with more than 32 specimens having been collected at only four stations. Three of these, located in the cyclonic gyre in the southwest, were dominated by *Desmopterus papilio* and *Cymbulia* sp. The other station was in the Antilles Current north of Puerto Rico and consisted mainly of over 80 very small individuals of *Peraclis* sp.

In vertical distribution, 96.7% of the total population was collected in the upper 200 m and 99.8% in the upper 500 m. Thecosomes were ubiquitous in the upper 200 m, occurring in all except three of the samples (two from the surface; one from 100 m). Below 500 m their occurrence was much sparser, with 12 of the 81 samples taken from 200 to 500 m devoid of thecosomes and 149 of 221 samples taken below 500 m lacking thecosomes.

The small number of specimens collected from the deeper waters can primarily be explained by the true scarcity of the individuals occurring there. Certain deep-living species, however, such as *Clio polita*, *C. recurva*, and the species of *Peraclis*, that occurred infrequently or not at all in this study, were collected by Tesch (1946) in moderate numbers in the Caribbean and tropical Atlantic. Tesch used large diameter nets with coarse meshes compared to the fine-meshed, small-mouthed nets of the present study, indicating the possibility of avoidance by the deeper living species. Avoidance is further supported by the fact that the larger, more mobile species such as *Cavolinia tridentata*, *C. uncinata*, and *C. gibbosa* were collected in very small numbers, if at all in this study, while they have been collected with the Isaacs-Kidd Midwater Trawl in sporadic (*C. tridentata*) to moderate (*C. uncinata* and *C. gibbosa*) numbers in the Caribbean (Haagensen,

unpublished data).

McGowan and Fraundorf (1966) documented net avoidance by thecosomes. They observed that as the diameter of a net mouth increased from 20 to 140 cm, the number of species and abundance of each species increased. The nets they used had a mesh size of 0.55 mm so their results apply best to the larger forms. They did not vary the mesh sizes, but presumedly as the net mesh size becomes smaller, avoidance by larger thecosomes would increase.

The earliest efforts to assign thecosome species to zoogeographic regions were those of Meisenheimer (1905, 1906a), who compiled all records of each species in the oceans of the world. On the basis of temperature and associations among the species, he set forth seven faunal regions: circumtropical, Arctic, Antarctic, North Atlantic transitional, North Pacific transitional, South American transitional, and South African mixed. Using large amounts of distributional data, Tesch (1946) modified and more clearly defined Meisenheimer's general categories. Tesch recognized six zoogeographic regions:

(1) Tropical, supporting populations of _Creseis virgula_, _Hyalocylis striata_, _Clio recurva_, _C. chaptalii_, _Diacria quadridentata_, _Cavolinia longirostris_, _C. uncinata_, _Corolla_ sp., _Gleba_ sp., and _Desmopterus_ sp.

(2) All warmer waters, with _Limacina inflata_, _L. lesueurii_, _L. trochiformis_, _L. bulimoides_, _Creseis acicula_, _Clio pyramidata_, _C. cuspidata_, _Cuvierina columnella_, _Diacria trispinosa_, _Cavolinia inflexa_, and _Cymbulia_ sp.

(3) Subtropical, characterized by _Styliola subula_ and _Cavolinia gibbosa_.

(4) Temperate: _Limacina retroversa_.

(5) Polar: _Limacina helicina_.

(6) Bathypelagic: Limacina helicoides, Clio polita, Peraclis bispinosa, and P. moluccensis.

With the advent of discrete depth plankton sampling and the increased use of concurrent hydrographic measurements, the faunal categories have become even more distinctly defined and based almost exclusively on temperature and depth. A synopsis of the recent works in this area is presented in Table 2, where "subtropical cold-tolerant" (Chen and Bé, 1964) and "subtropical" (Myers, 1968; Chen and Hillman, 1970) are equivalent as are "subtropical warm-tolerant" (Chen and Bé, 1964) and "tropical" (Myers, 1968; Chen and Hillman, 1970). The faunal categories assigned to each species are identical in the studies by Chen and Bé (1964), Myers (1968) and Chen and Hillman (1970), with the exception of the species of Peraclis.

Austin (1971), in contrast, reduced the ranges of the tropical and subtropical categories of the previous authors and added a temperate category. As a consequence, some species that previously had been classified as tropical, such as Creseis acicula, C. virgula conica and Cavolinia inflexa, he considered subtropical, and Clio pyramidata, previously classified as subtropical, he considered temperate species. Two of his assignments, however, contradicted previous works and could not be explained on the basis of revised categories. He classified Limacina lesueurii as tropical, when all other workers had considered it as subtropical, and he designated Hyalocylis striata as temperate, when all other workers reported it as tropical.

In analyzing the present data, a tentative explanation for this difference in Austin's opinion and that of other workers became apparent. In the Caribbean, more than half of the thecosomes, including Limacina

Table 2

Faunal categories of thecosomata based on literature

Species	Chen & Bé (1964)[1] Western North Atlantic	Myers (1968)[2] Cape Hatteras Area	Chen & Hillman (1970)[3] Cape Hatteras Area	Austin (1971)[4] Gulf of Mexico
	Author and Area			
L. inflata	subtropical cold-tolerant	subtropical	subtropical	subtropical
L. lesueurii	" "	"	"	tropical
L. trochiformis	subtropical warm-tolerant	tropical	tropical	"
L. bulimoides	subtropical cold-tolerant	subtropical	subtropical	
Cr. acicula	subtropical warm-tolerant	tropical	tropical	subtropical
Cr. virgula f. virgula	" "	"	"	tropical
Cr. v. f. conica	" "	"	"	subtropical
Cr. chierchiae		"		
S. subula	subtropical cold-tolerant	subtropical	subtropical	
H. striata	subtropical warm-tolerant	tropical	tropical	temperate
Cl. pyramidata	subtropical cold-tolerant	subtropical	subtropical	"
Cl. cuspidata				"
Cl. polita	subtropical cold-tolerant	subtropical		
Cuv. columnella	" "	"	subtropical	temperate
D. trispinosa	" "	"	"	
D. quadridentata	" "	"	"	
Cav. longirostris	subtropical warm-tolerant	tropical	tropical	tropical
Cav. uncinata	" "	"	"	
Cav. gibbosa	" "	"		
Cav. inflexa	" "	"	tropical	subtropical
P. reticulata		deep	subtropical	temperate
P. bispinosa		"	"	"
P. moluccensis				boreal
P. apicifulva		deep	subtropical	

[1]Criteria for their categories: subtropical cold tolerant-14.2 to 27.7°C, optimum 18-22°C, 35.5-36.7‰; subtropical warm-tolerant: 16.8 to 27.9°C, optimum 24-27°C, 35.5-36.7‰.

[2] No criteria provided for his groupings; Myers stated that his tropical category corresponded to Chen and Bé's (1964) subtropical warm-tolerant.

[3] Used same criteria as Chen and Bé (1964), but designated Chen and Bé's subtropical cold-tolerant as subtropical and their subtropical warm-tolerant as tropical.

[4] Criteria for his categories: tropical-greater than 28°C, surface to 75 m (summer); subtropical-21 to 28°C, surface to 100 m (spring); temperate-15 to 21°C, surface (winter), 100 to 200 m (summer); boreal-15°C, surface (winter), greater than 300 m (spring-summer).

lesueurii and Hyalocylis striata, did not fit neatly into any of the designated faunal categories. The categories worked well when applied to a species that continually occupied only one water mass, but did not function when applied to a species that migrated diurnally between two water masses. For example, during the day L. lesueurii occupied the middle depths of the Subtropical Underwater under conditions Chen and Hillman (1970) would have termed subtropical. At night, however, this species was found in the Tropical Surface Water under conditions Austin (1971) would have described as tropical. H. striata showed the same day to night migration between water masses.

Although Austin and most other authors discussed diurnal migration, none of them considered it in assigning their faunal categories. Since the main purpose of erecting faunal categories is to characterize water masses with certain species, their failure to consider diurnal migration could have resulted in the designation of incorrect indicator species. Certainly a species such as L. lesueurii could not be considered only as an indicator of tropical waters, when it occurred with equal frequency in subtropical waters. Thus, not only must it be ascertained what water mass a species occupies, but also when, and under what conditions.

On the basis of the water masses they occupied during the day and night, the thecosome species in the Caribbean can be separated into several distinct groupings, only two of which correspond to the faunal categories in Table 2. The first group is composed of species that were present in the tropical surface water mass at all times and thus belong to the tropical faunal category. These are:

Limacina trochiformis-adults and juveniles

Creseis acicula f. *acicula*-adults and juveniles

C. virgula f. *virgula*-adults and juveniles

C. virgula f. *conica*-adults and juveniles

C. chierchiae-all individuals

Cavolinia longirostris-adults and juveniles

Corolla spp.-all individuals

Gleba cordata-all individuals

These species occurred within a temperature range of 26-27 to 29.3°C and a salinity range of 34.16 to 36.50°/₀₀, from the surface to approximately 100 m. *L. trochiformis* and *Cavolinia longirostris* showed definite migrations within the water mass toward the surface at night. *C. acicula* f. *acicula* and *C. virgula* f. *virgula* exhibited slight upward migrations at night and *C. virgula* f. *conica* showed a weak migration away from the surface at night. *Corolla* spp. apparently does not migrate, and the remaining two species were collected in such small numbers that no pattern could be established.

The only other species that were restricted to one water mass were *Clio cuspidata* (juveniles), *Peraclis reticulata*, *P. bispinosa*, *P. apicifulva* and *Desmopterus gardineri*, which were collected in the Subtropical Underwater and showed no tendency to migrate out of this water. Their distribution places them in Chen and Hillman's (1970) subtropical category and Austin's (1971) subtropical, temperate and boreal categories. *P. bispinosa*, *P. apicifulva* and *D. gardineri* were found principally from a depth of 200 to 300 m in the middle of the water mass, where temperatures ranged from 14.5 to 20.5°C and salinities from 35.5 to 36.75°/₀₀. *Clio cuspidata* occurred near the bottom of the Subtropical Underwater at depths from 400 to 525 m, with temperatures

between 8 and 13°C and salinities between 34.75 and 35.75°/₀₀. P. reticulata, though collected only in small numbers, occurred almost entirely within the core of the water mass, at temperatures of 18.5 to 27.5°C and salinities greater than 36.25°/₀₀. P. moluccensis and P. triacantha probably belong in this group, but were not collected in numbers sufficient to establish their distributions.

The remainder of the thecosome species exhibited diurnal vertical migrations of varying scope between the Subtropical Underwater and the Tropical Surface Water. The strongest migrators were the adults of Limacina lesueurii, L. bulimoides, Cuvierina columnella, Diacria trispinosa and Cavolinia inflexa, which occurred almost exclusively in the Subtropical Underwater during the day and in the Tropical Surface Water at night. Their ranges, however, were restricted to the two water masses. They predominated in the ranges of 14 to 20°C and 35.5 to 36.75°/₀₀ in the Subtropical Underwater. Three species, L. bulimoides, C. columnella and D. trispinosa, appeared to avoid salinities lower than 35.00°/₀₀ in the Tropical Surface Water. The juveniles of these five species were found in both water masses during the day, with their highest numbers in the Subtropical Underwater. At night, they occurred chiefly in the Tropical Surface Water . Although only a small number of Clio pyramidata, mostly juveniles, were collected, they had a diurnal distribution similar to the adults of this group.

The adults of five species, Styliola subula, Hyalocylis striata, Diacria quadridentata, Cavolinia uncinata, and Cymbulia sp., occupied the upper two water masses below 50 m during the day. At night, they migrated into the Tropical Surface Water , extending to the surface. During the day, S. subula had a distribution over the entire Subtropical

Underwater, while the other four species occupied approximately the upper two-thirds of it. The juvenile distributions of the three species, unlike the adults, had different distributions from one another. The juveniles of _S_. _subula_ had the same distribution as their adults; the juveniles of _H_. _striata_ occupied the Subtropical Underwater by day and the Tropical Surface Water by night; and the juveniles of _D_. _quadridentata_ occurred in both water masses during the day and night.

The final group, _Limacina inflata_ (adults) and _Desmopterus papilio_, were found in the two upper water masses during the day and the night. The average depth for each species was in the Subtropical Underwater during the day and in the Tropical Surface Water at night. _D_. _papilio_ was restricted in its movements to waters warmer than 13.5°C and more saline than 35.7°/₀₀. _L_. _inflata_, in contrast, populated waters from 2000 m to the surface, from 5 to 29°C, and from 32.7 to nearly 37 °/oo. The juveniles of _L_. _inflata_ were always present in both water masses, but their greatest numbers were concentrated in the Tropical Surface Water.

In summation, indicators of the Tropical Surface Water in the Caribbean are:

Limacina lesueurii-during the night, adults only

_L_. _trochiformis_-adults and juveniles

_L_. _bulimoides_-during the night, adults only

Creseis acicula f. _acicula_-adults and juveniles

_C_. _virgula_ f. _virgula_-adults and juveniles

_C_. _virgula_ f. _conica_-adults and juveniles

_C_. _chierchiae_-all individuals

Styliola subula-during the night, adults and juveniles

Hyalocylis striata-during the night, adults and juveniles

Cuvierina columnella-during the night, adults and juveniles

Diacria trispinosa-during the night, adults and juveniles

D. quadridentata-during the night, adults only

Cavolinia longirostris-adults and juveniles

C. uncinata-during the night, adults only

C. inflexa-during the night, adults and juveniles

Cymbulia sp.-during the night

Corolla spp.-all individuals

Gleba cordata-all individuals

Indicators of the Subtropical Underwater are:

Limacina lesueurii-during the day, adults only

L. bulimoides-during the day, adults only

Hyalocylis striata-during the day, juveniles only

Clio pyramidata-during the day, juveniles only

Clio cuspidata-juveniles

Cuvierina columnella-during the day, adults only

Diacria trispinosa-during the day, adults only

Cavolinia inflexa-during the day, adults only

Peraclis reticulata-all individuals

P. bispinosa-all individuals

P. triacantha-all individuals

Desmopterus gardineri-all individuals

Most of these indicators can occur in small numbers as emigrants in waters other than the ones they normally characterize. Mere presence of a species, therefore, is not necessarily indicative of a particular

water mass. Rather, frequency of occurrence and relative abundance should be the determining criteria.

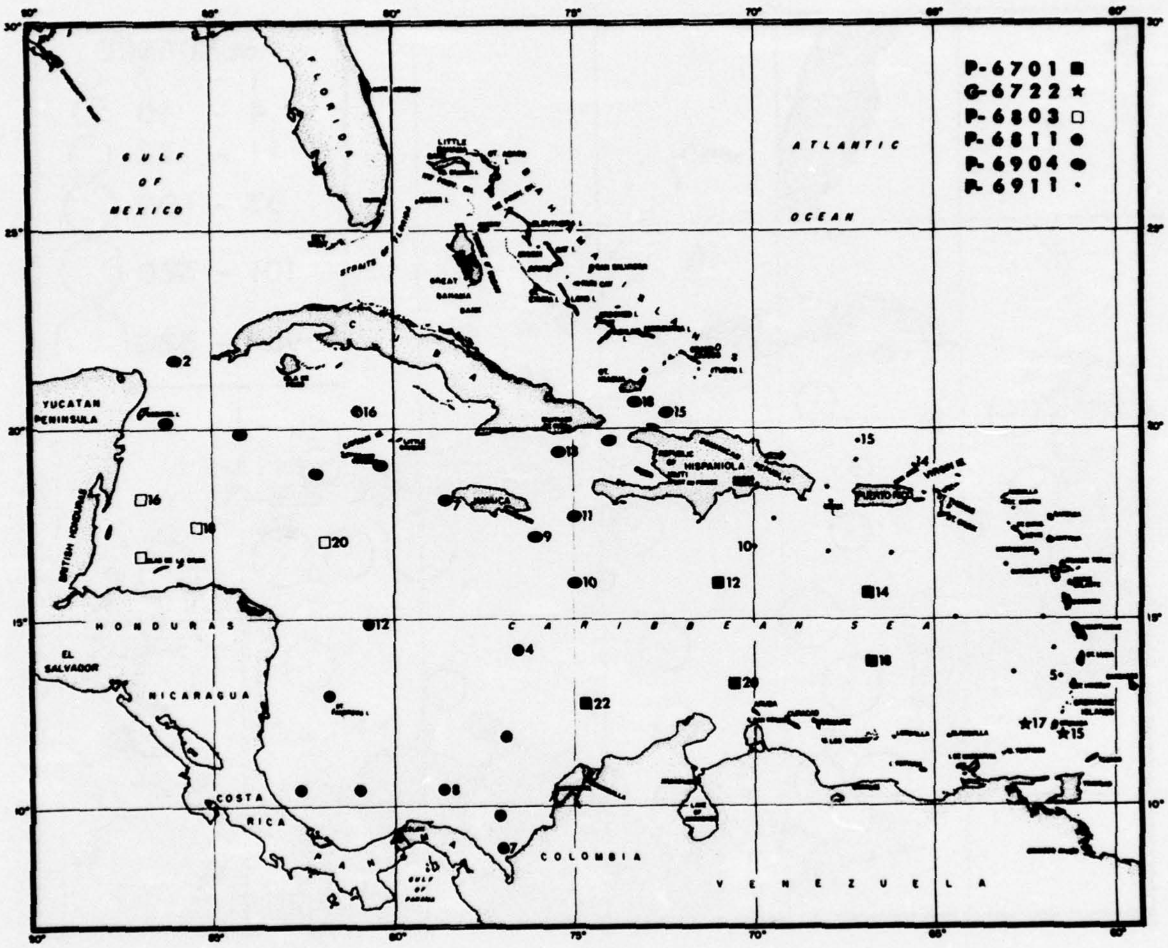

Figure 1. Cruise numbers and geographic locations of stations analyzed for Thecosomata.

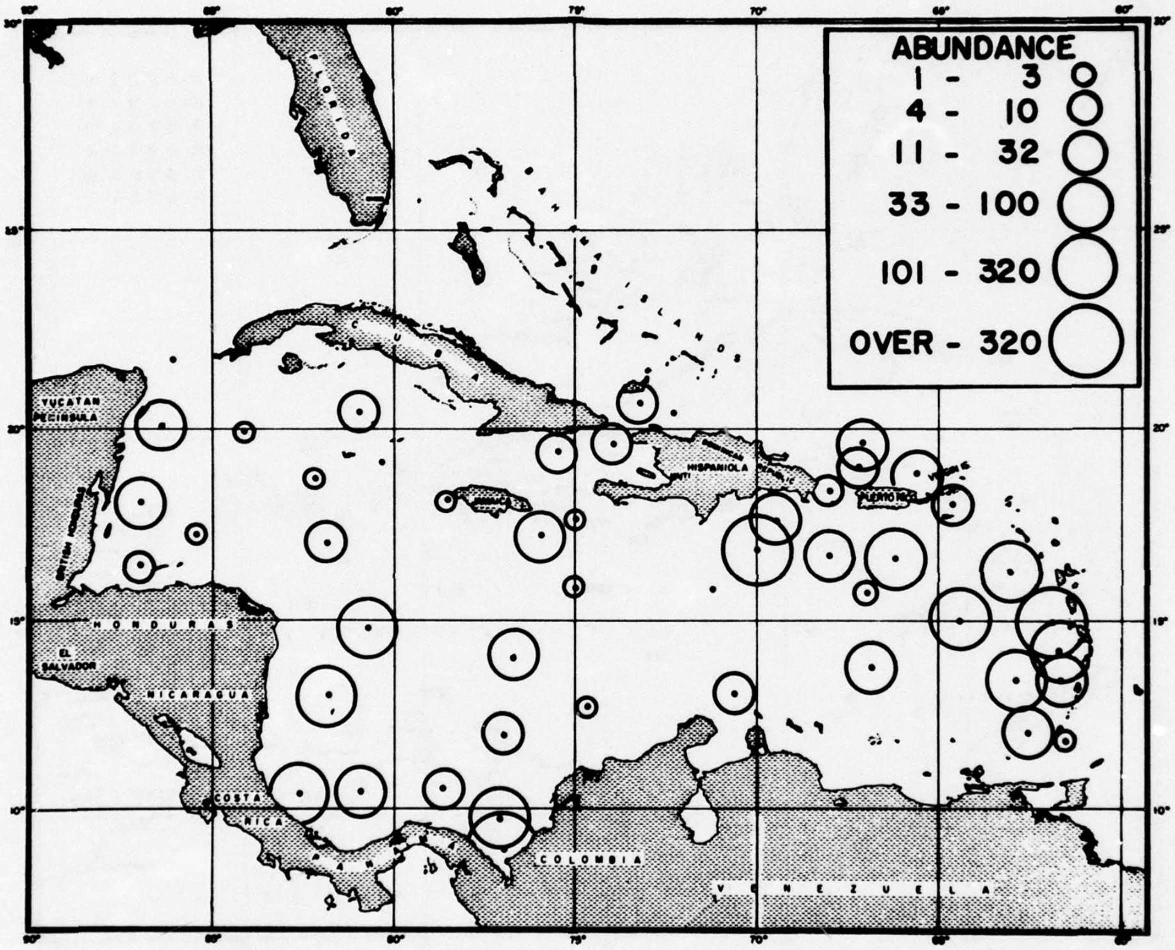

Figure 2. Horizontal distribution of the adults of <u>Limacina inflata</u>.

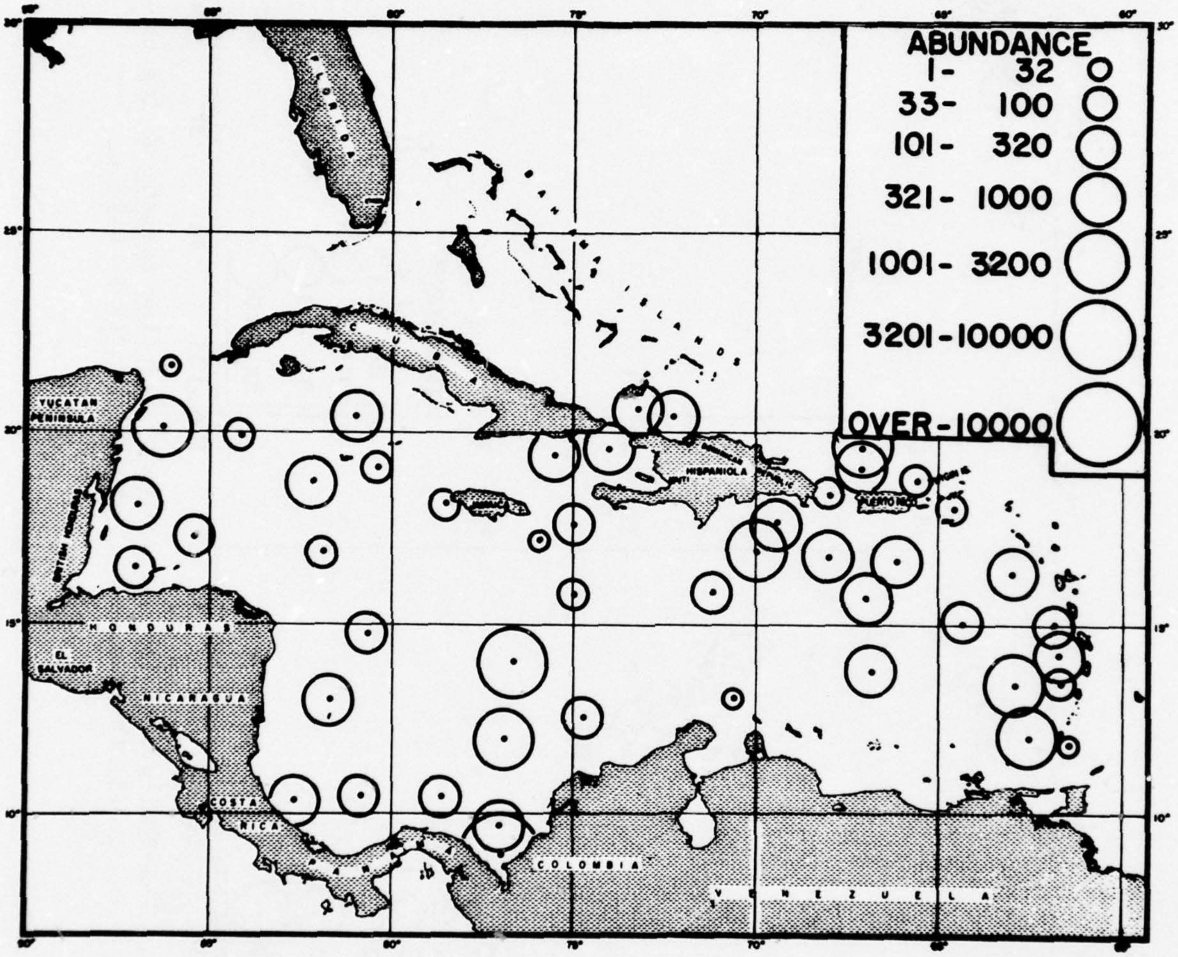

Figure 3. Horizontal distribution of the juveniles of
Limacina inflata.

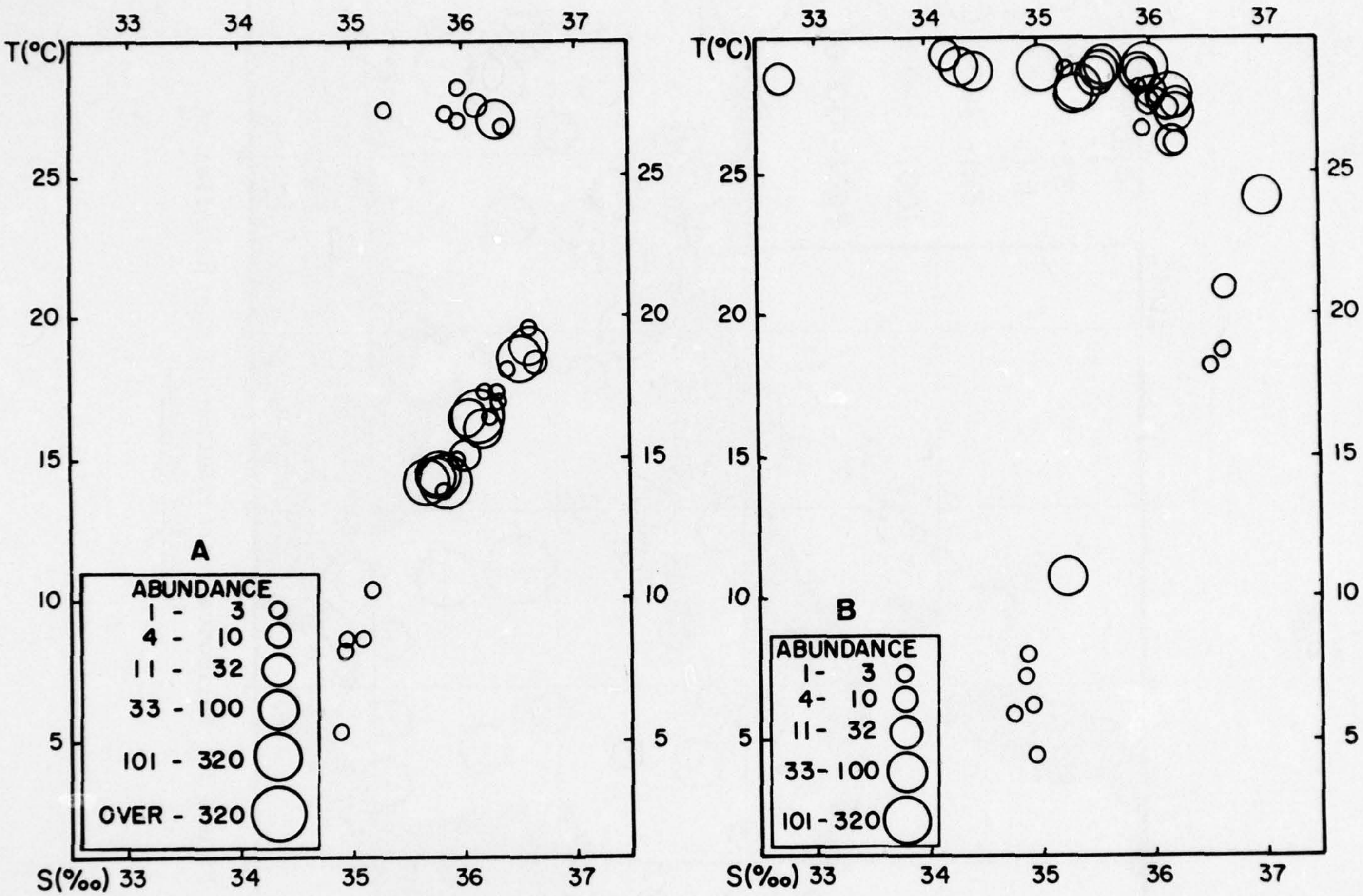

Figure 4. T-S-P diagrams, (A) the adults of <u>Limacina inflata</u> during the day and (B) the adults of <u>Limacina inflata</u> at night.

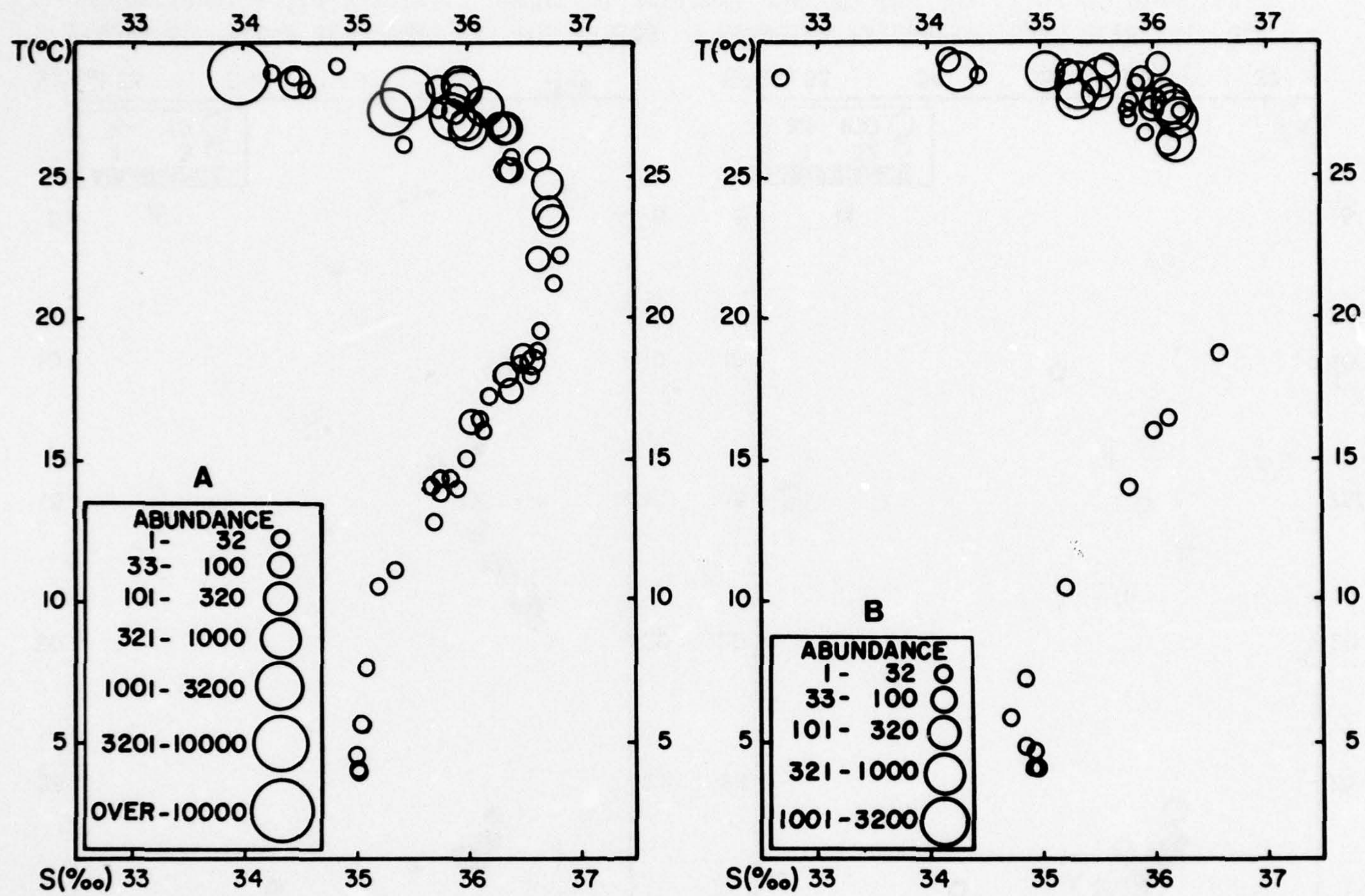

Figure 5. T-S-P diagrams, (A) the juveniles of Limacina inflata during the day and (B) the juveniles of Limacina inflata at night.

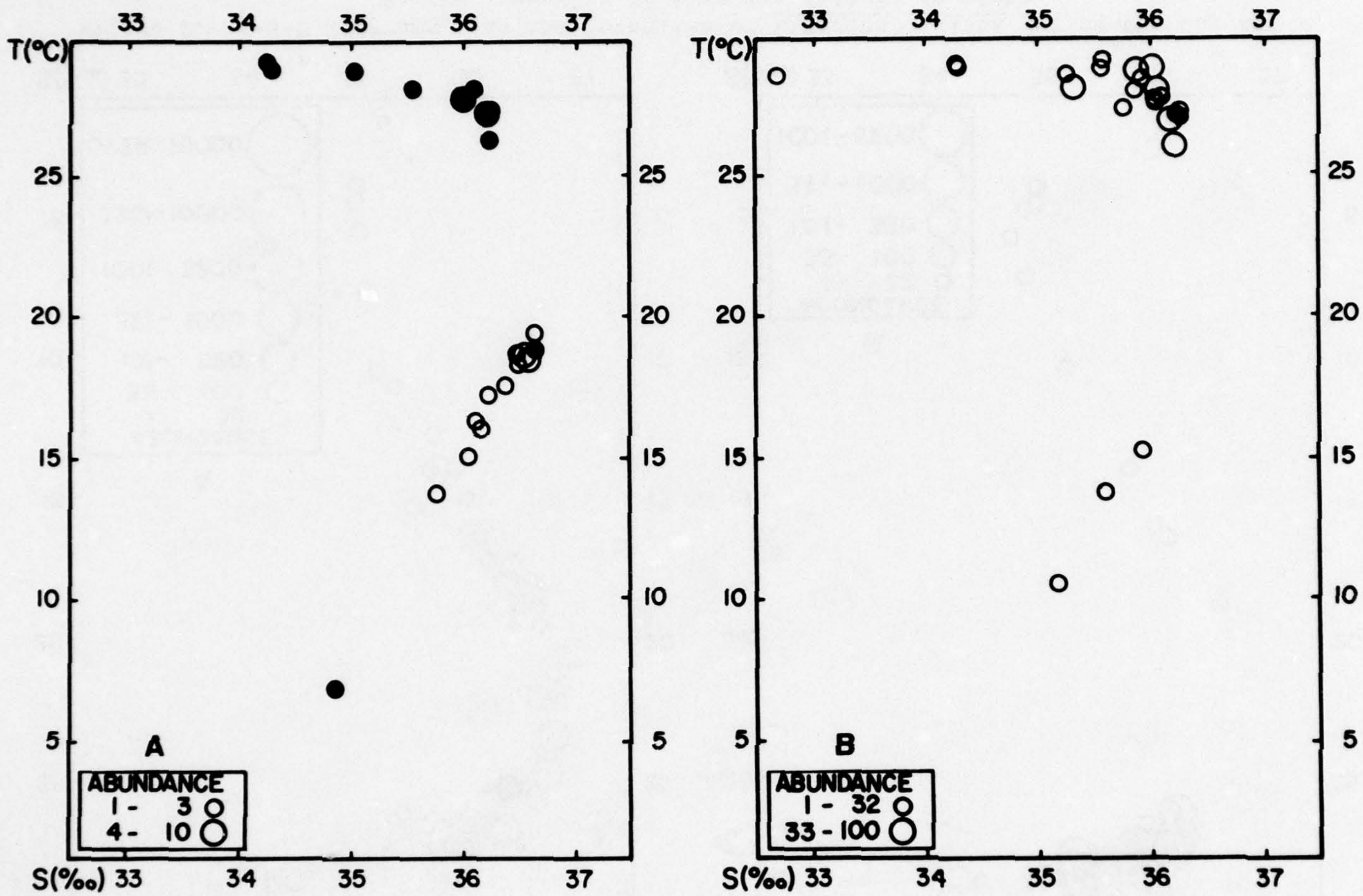

Figure 6. T-S-P diagrams, (A) the adults of Limacina lesueurii (Open circles: day collections; solid circles: night collections) and (B) the juveniles of <u>Limacina trochiformis</u> at night.

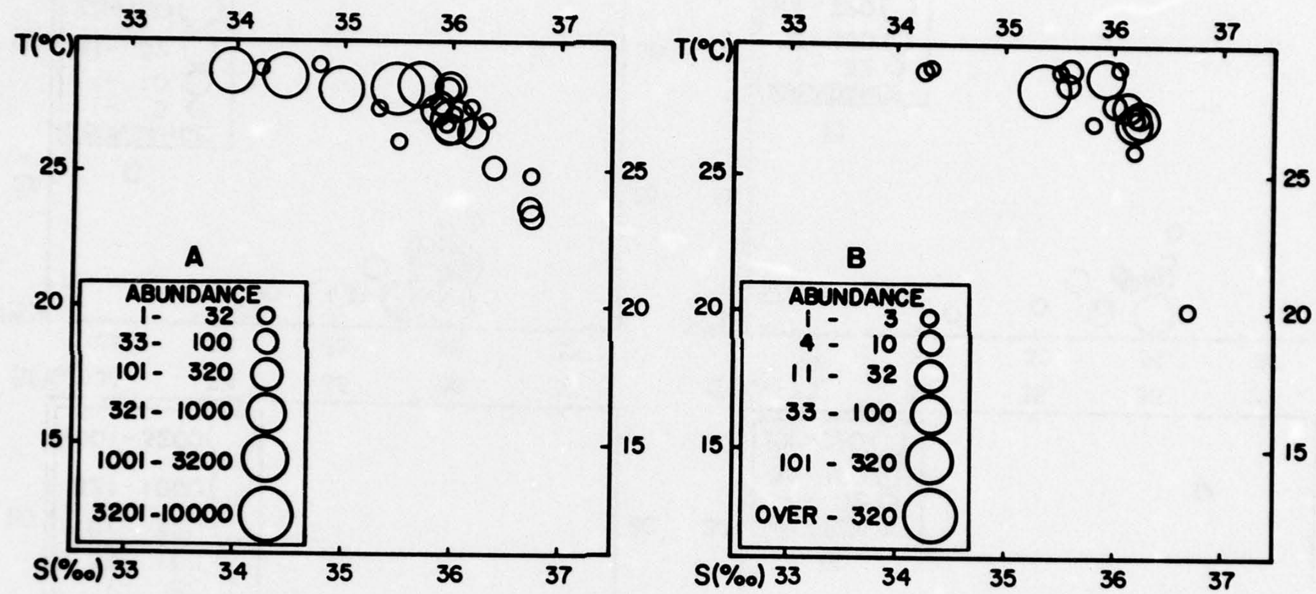

Figure 7. T-S-P diagrams, (A) the unidentified juveniles of <u>Limacina trochiformis</u> or <u>Limacina bulimoides</u> during the day and (B) the adults of <u>Creseis virgula</u> f. <u>conica</u> at night.

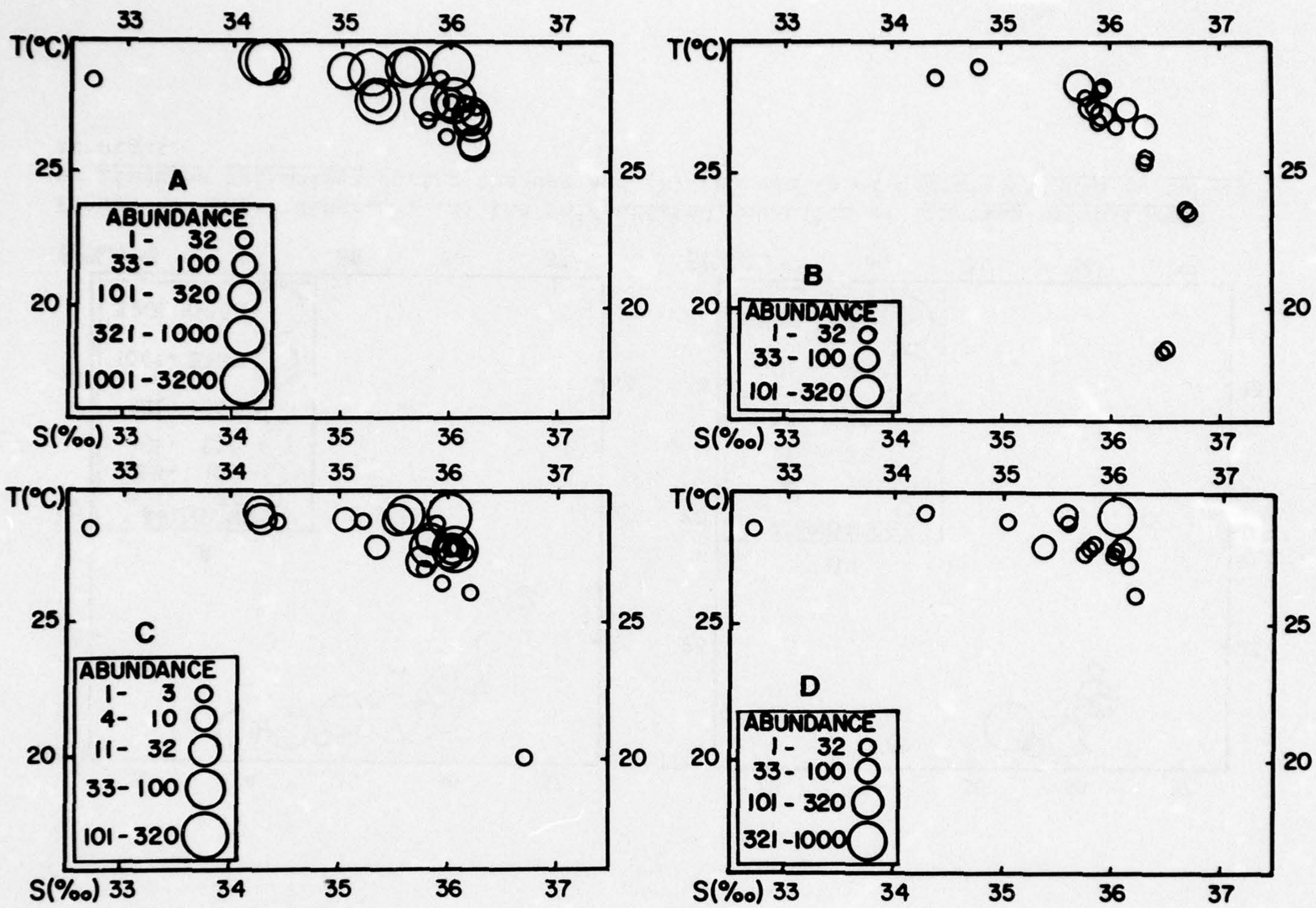

Figure 8. T-S-P diagrams, (A) the unidentified juveniles of Limacina trochiformis or Limacina bulimoides at night, (B) the juveniles of Limacina trochiformis during the day, (C) the adults of Creseis acicula f. acicula at night, and (D) the juveniles of Creseis acicula f. acicula at night.

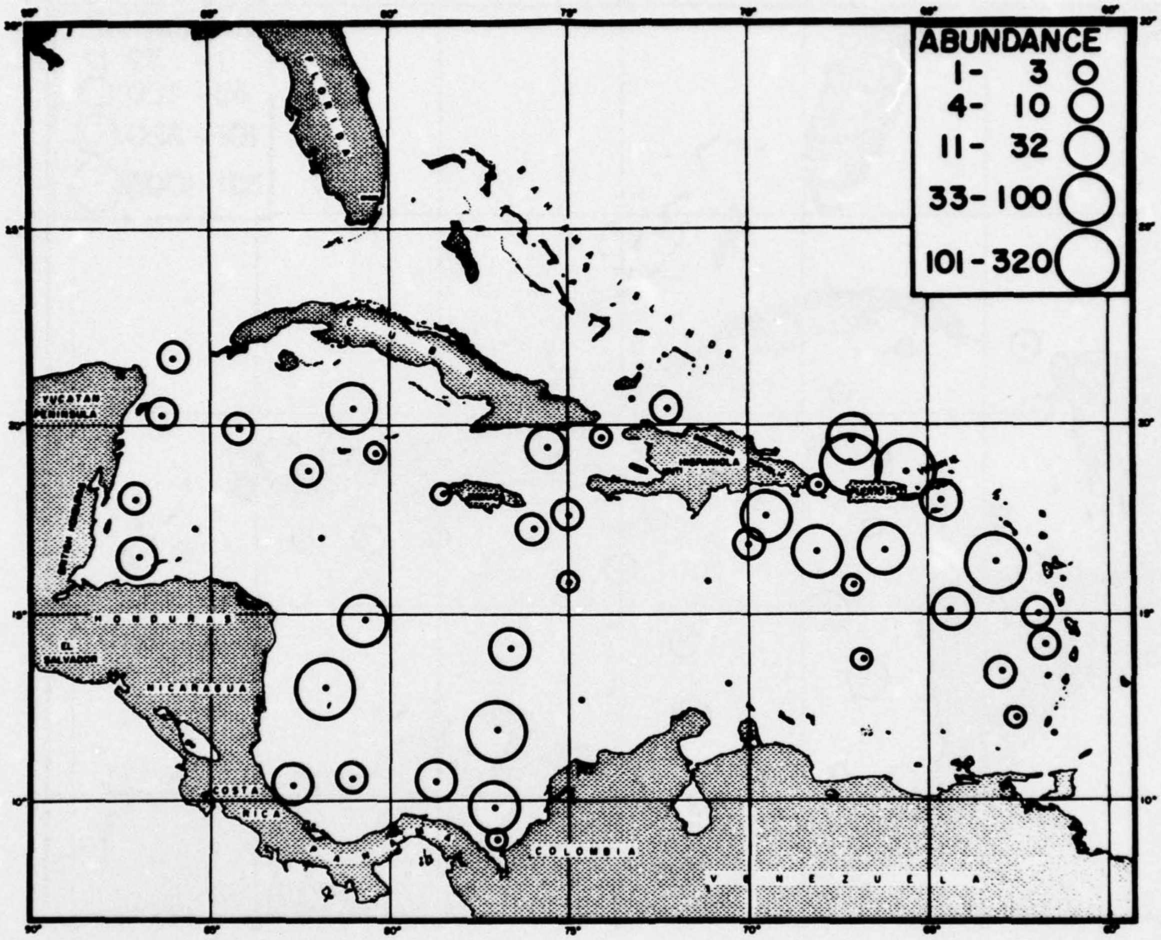

Figure 9. Horizontal distribution of the adults of Limacina trochiformis.

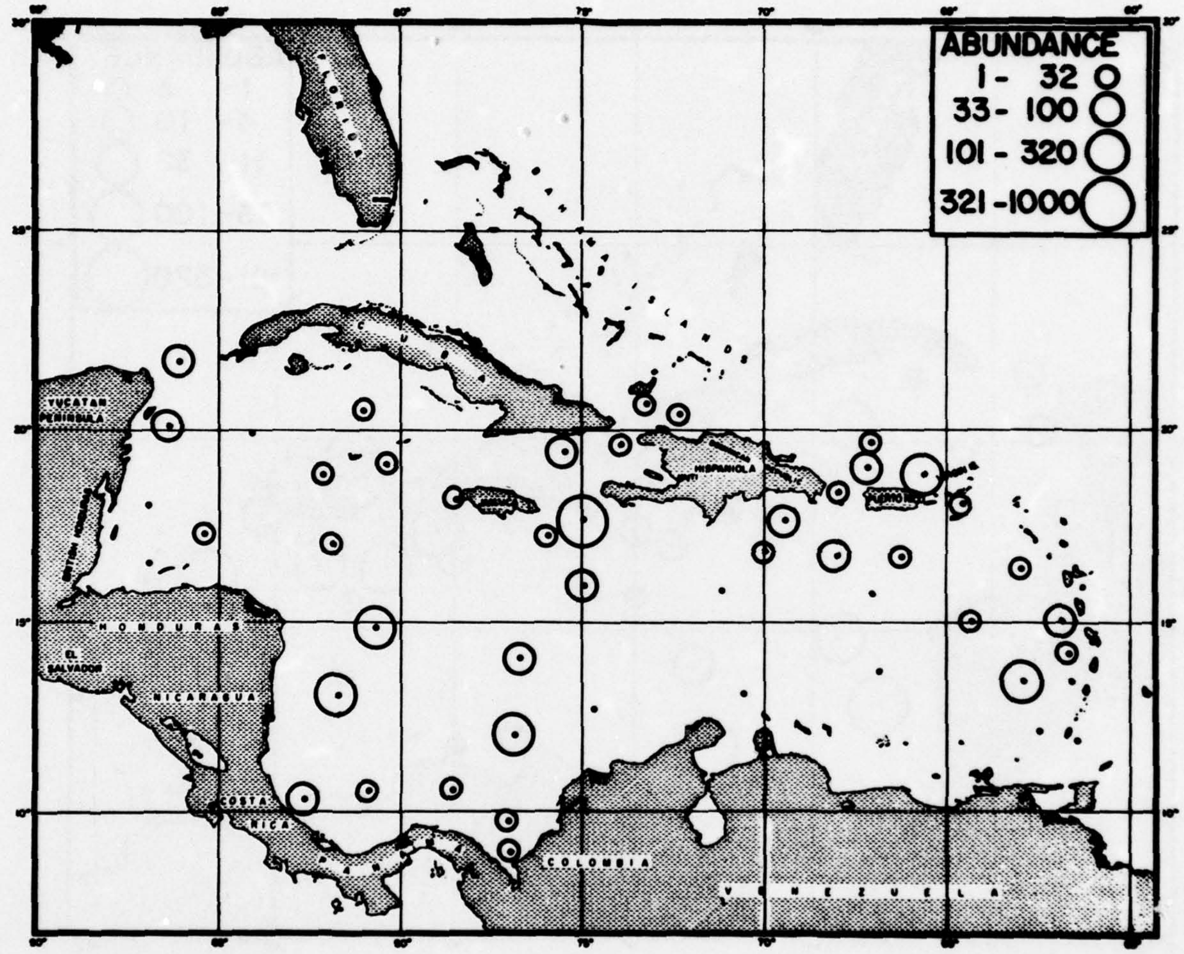

Figure 10. Horizontal distribution of the juveniles of
<u>Limacina</u> <u>trochiformis</u>.

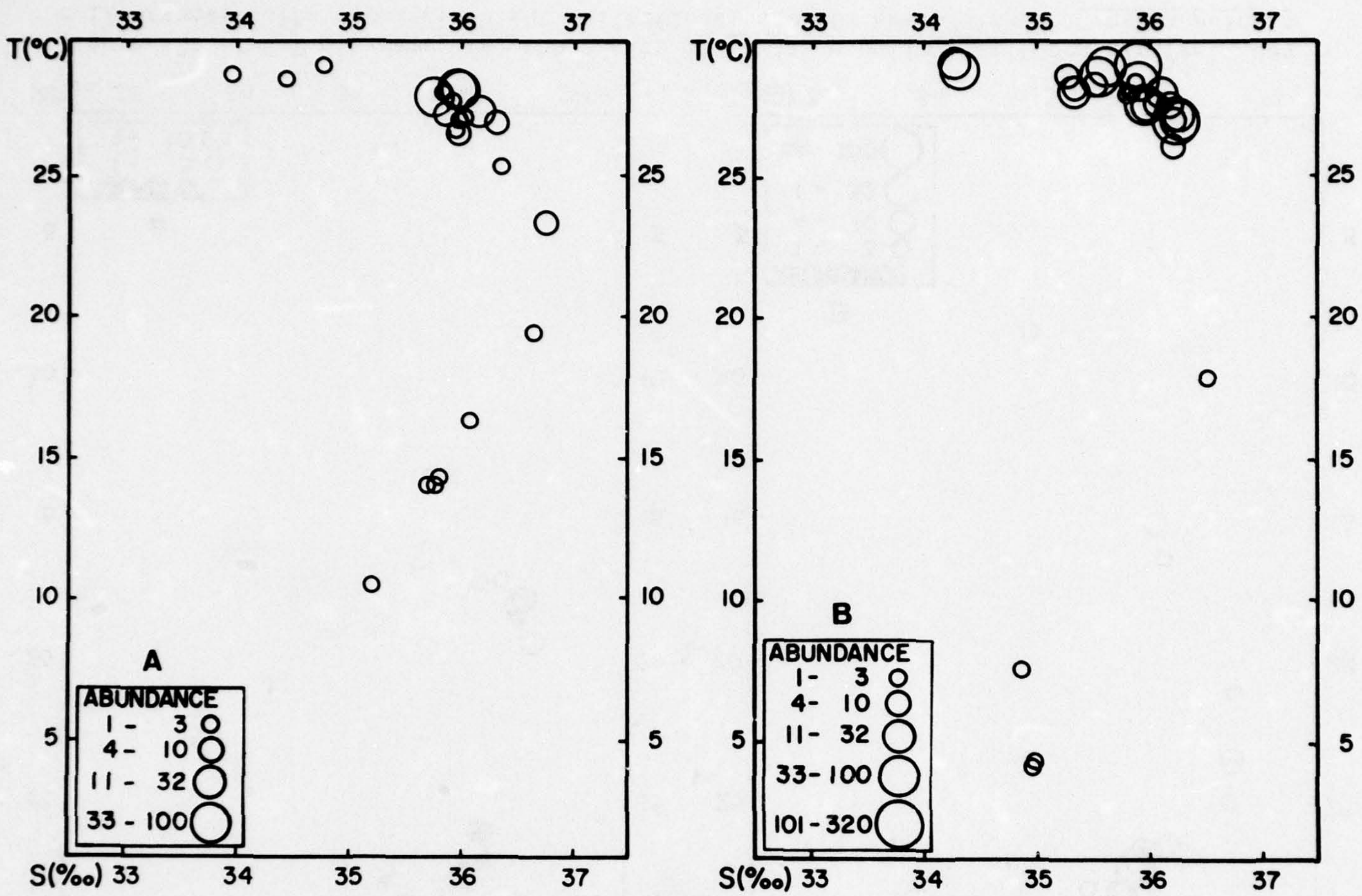

Figure 11. T-S-P diagrams, (A) the adults of Limacina trochiformis during the day and (B) the adults of Limacina trochiformis at night.

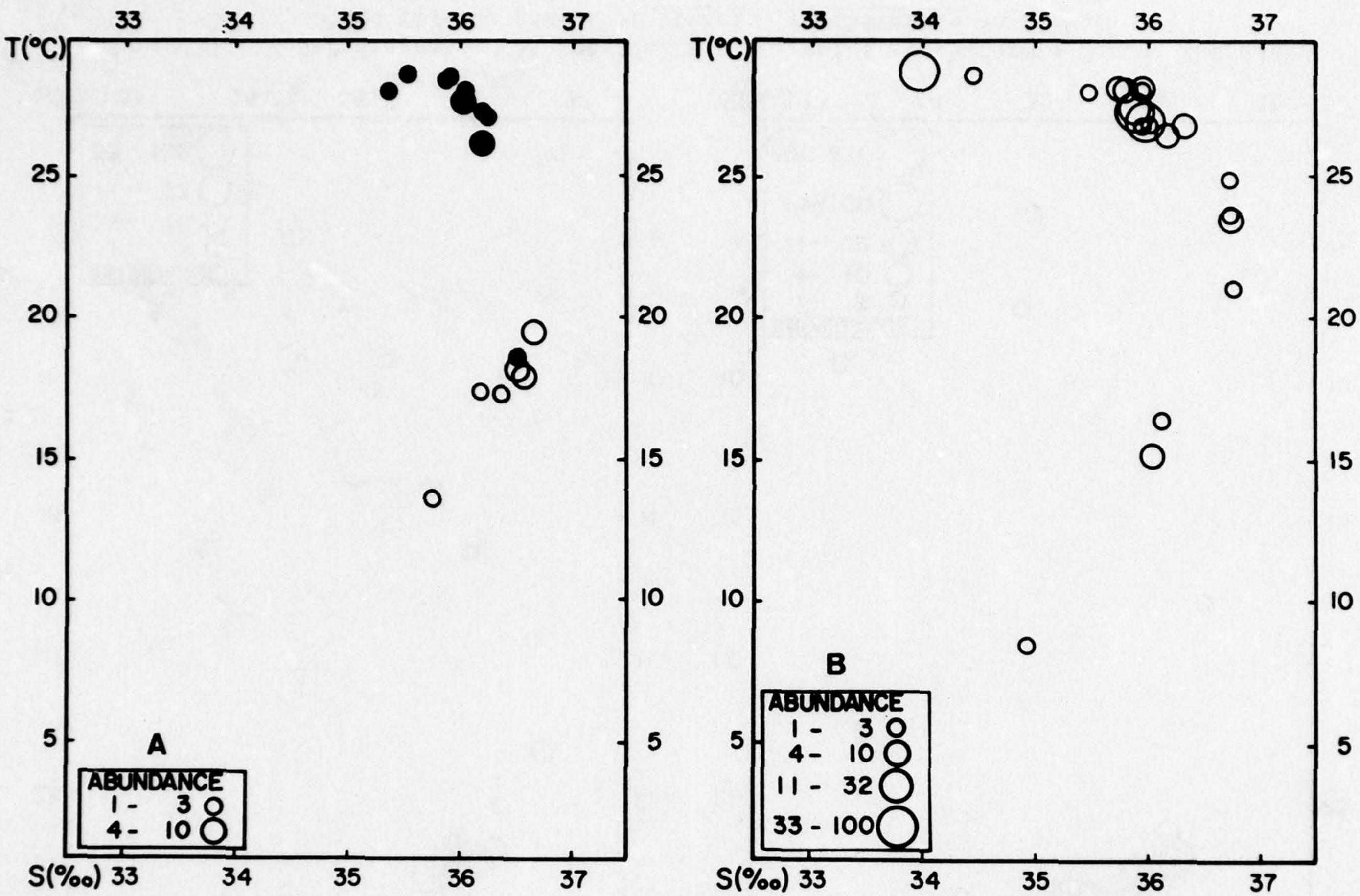

Figure 12. T-S-P diagrams, (A) the adults of <u>Limacina bulimoides</u> (Open circles: day collections; solid circles: night collections) and (B) the adults of <u>Creseis acicula</u> f. <u>acicula</u> during the day.

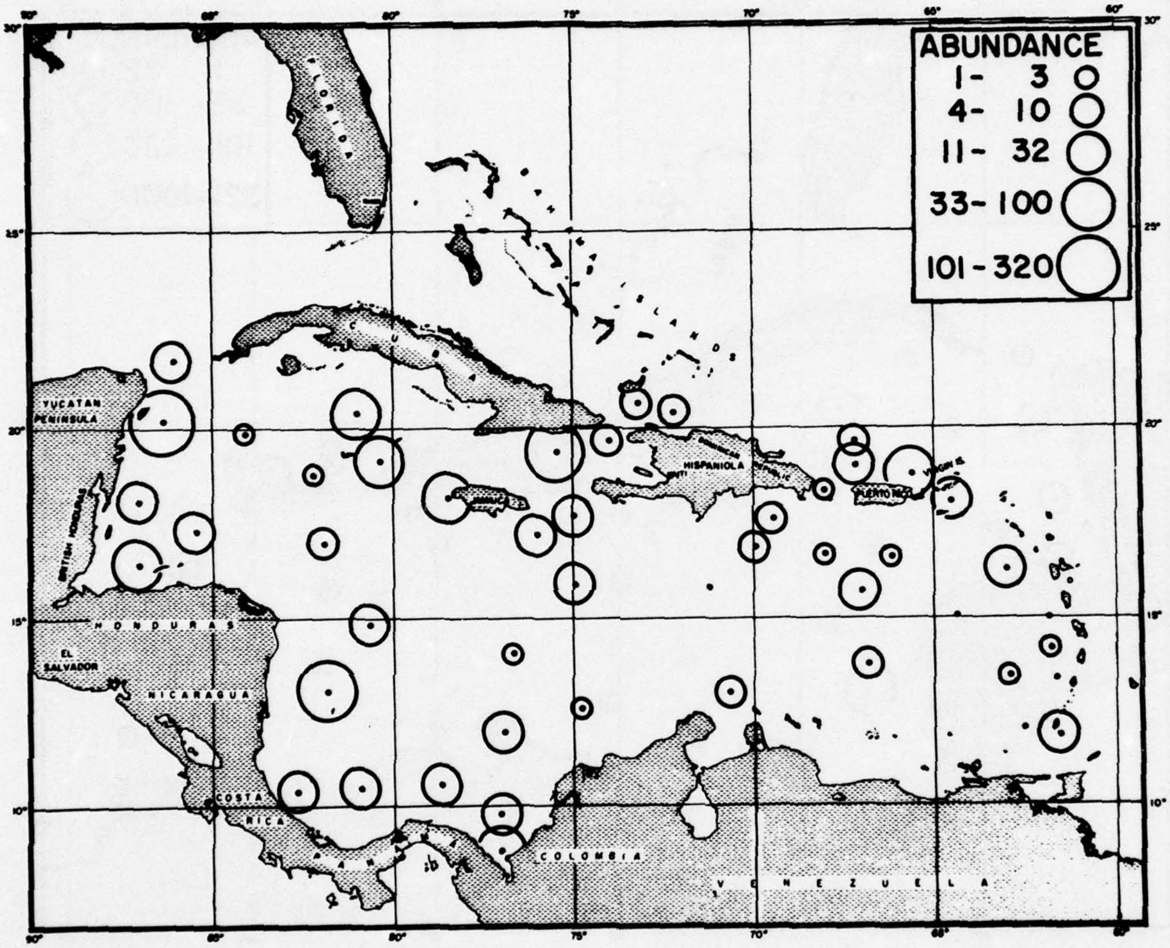

Figure 13. Horizontal distribution of the adults of Creseis acicula.

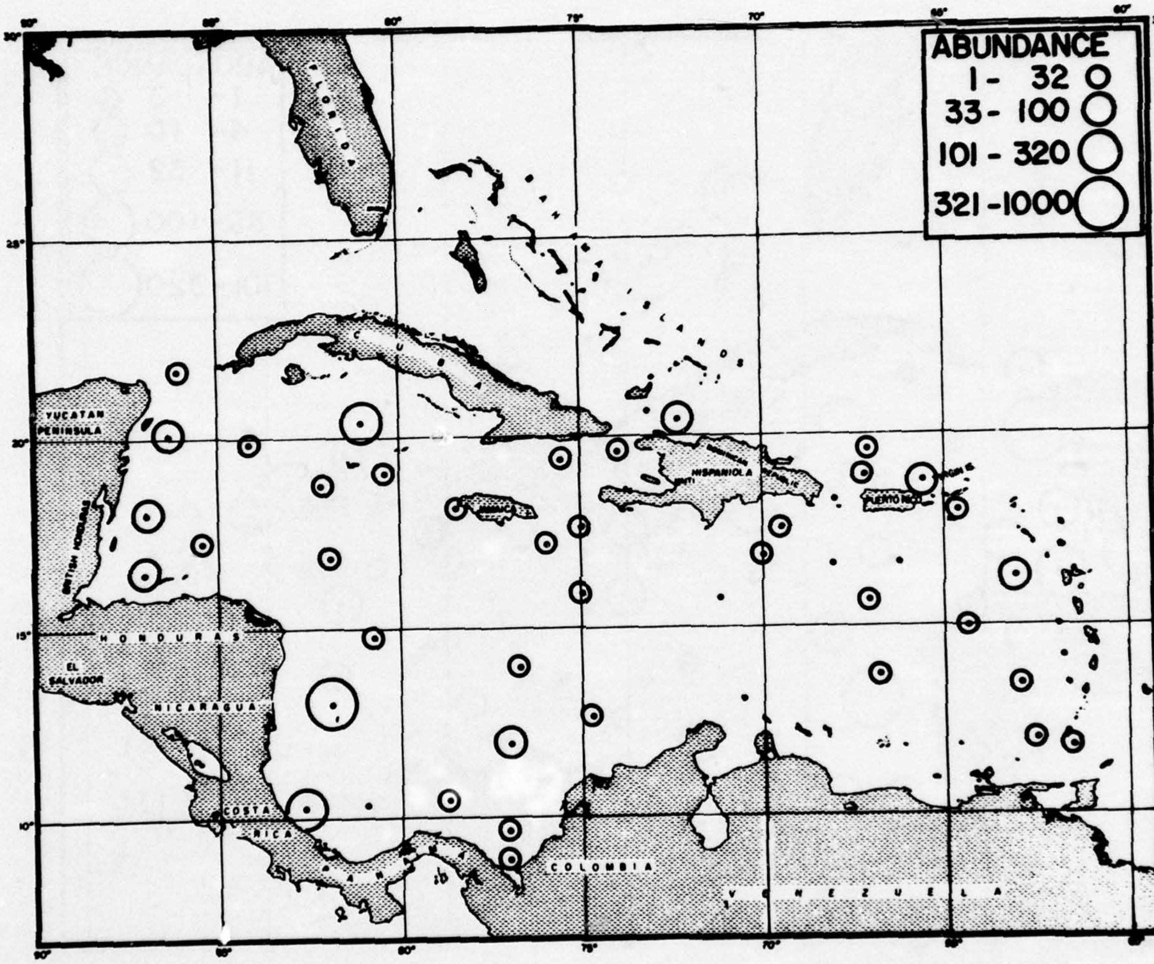

Figure 14. Horizontal distribution of the juveniles of Creseis acicula.

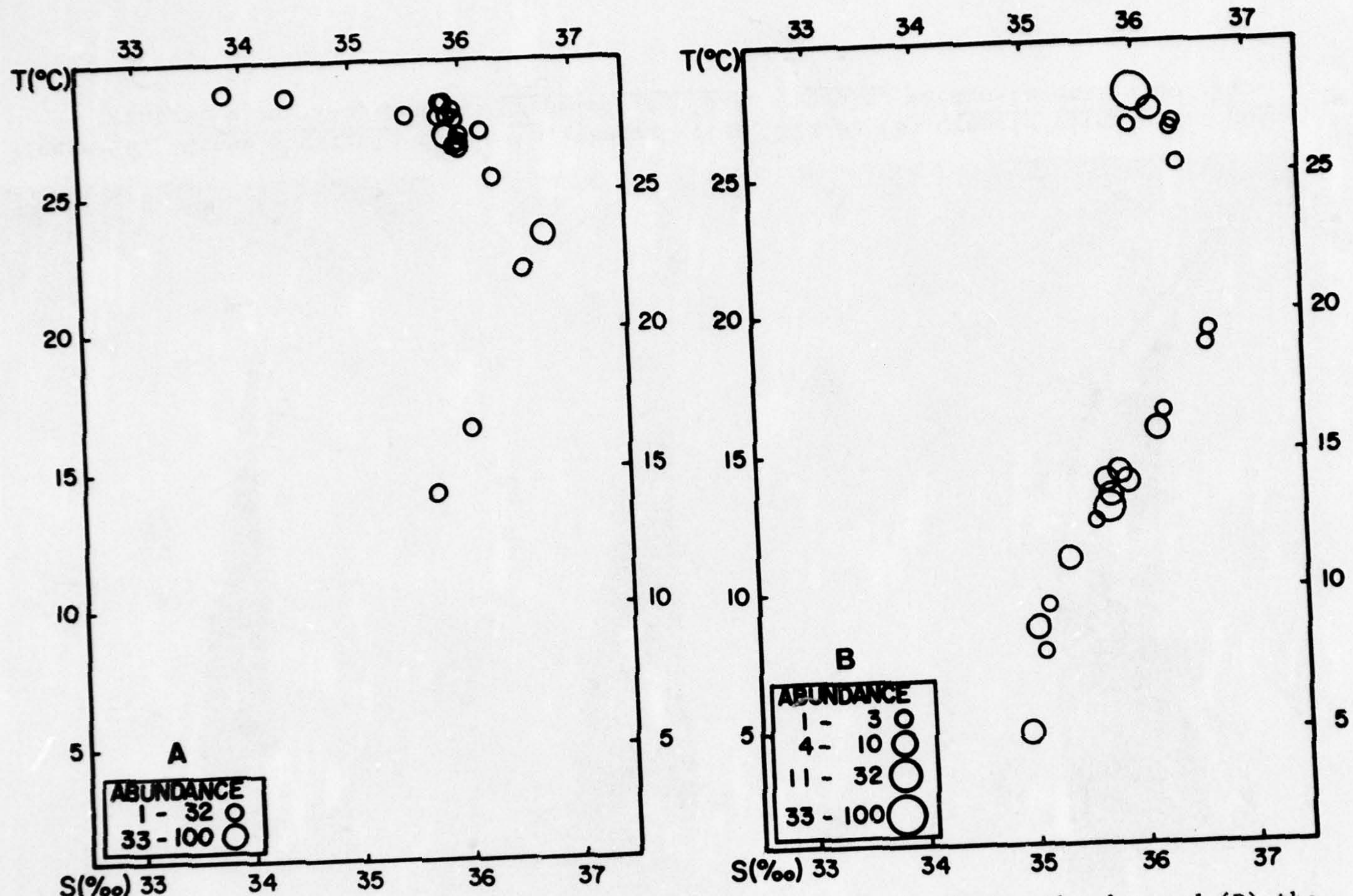

Figure 15. (A) the juveniles of <u>Creseis acicula</u> f. <u>acicula</u> during the day and (B) the adults of <u>Styliola subula</u> during the day.

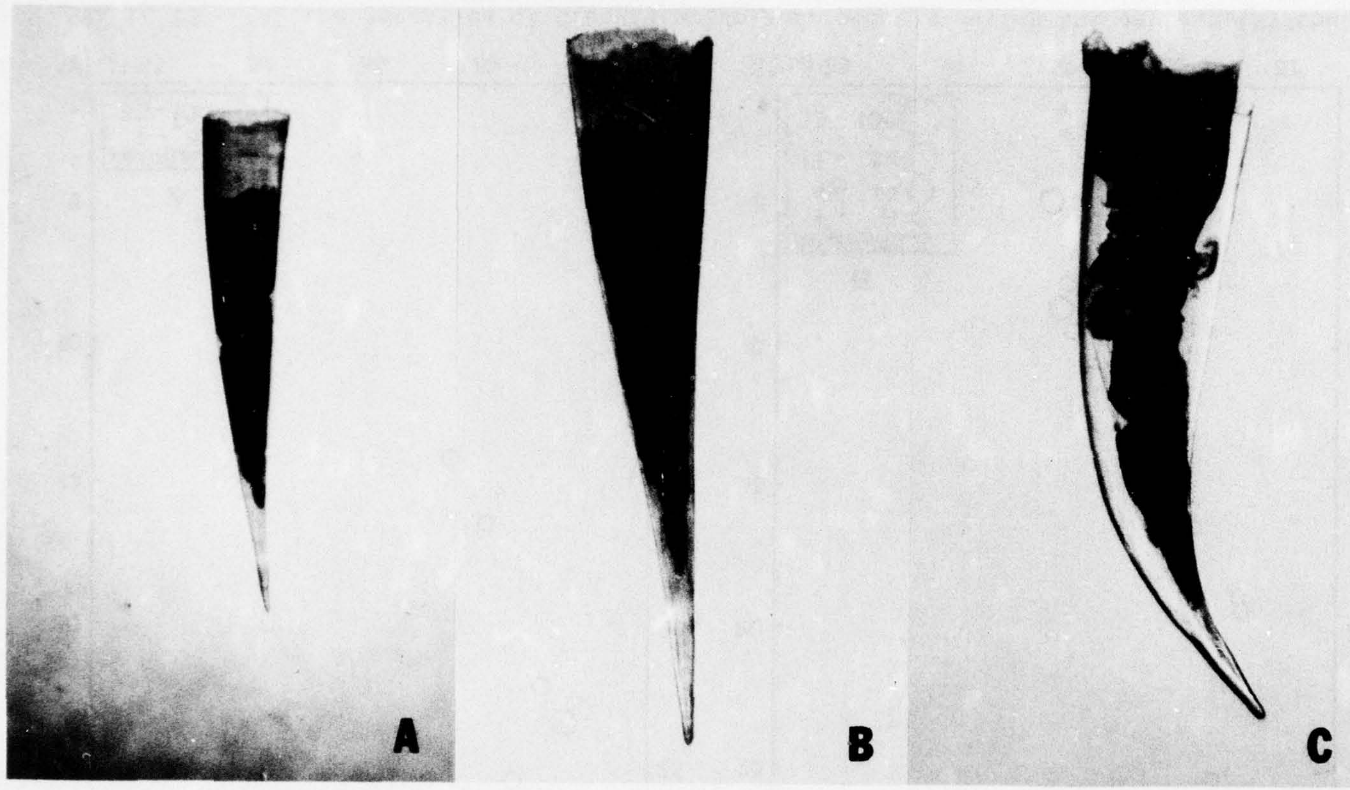

Figure 16. Creseis virgula f. conica, ventral view, X22.5, (B) Creseis virgula f. conica, ventral view, X45, and (C) Creseis virgula f. virgula, ventro-lateral view, X45.

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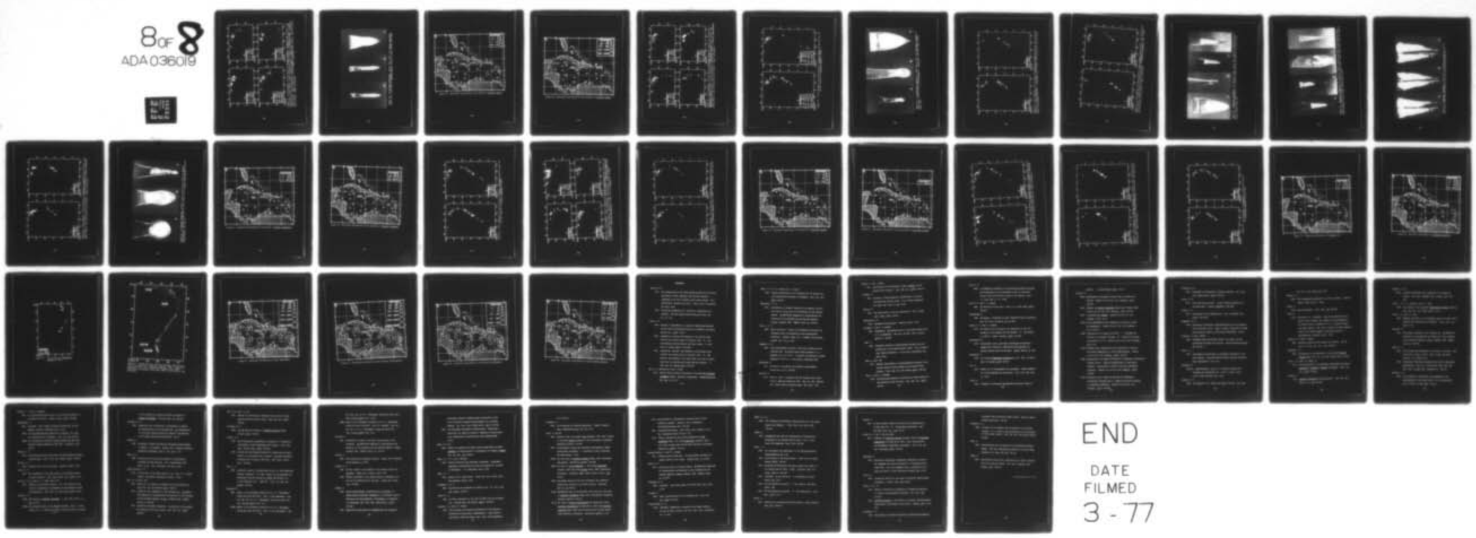

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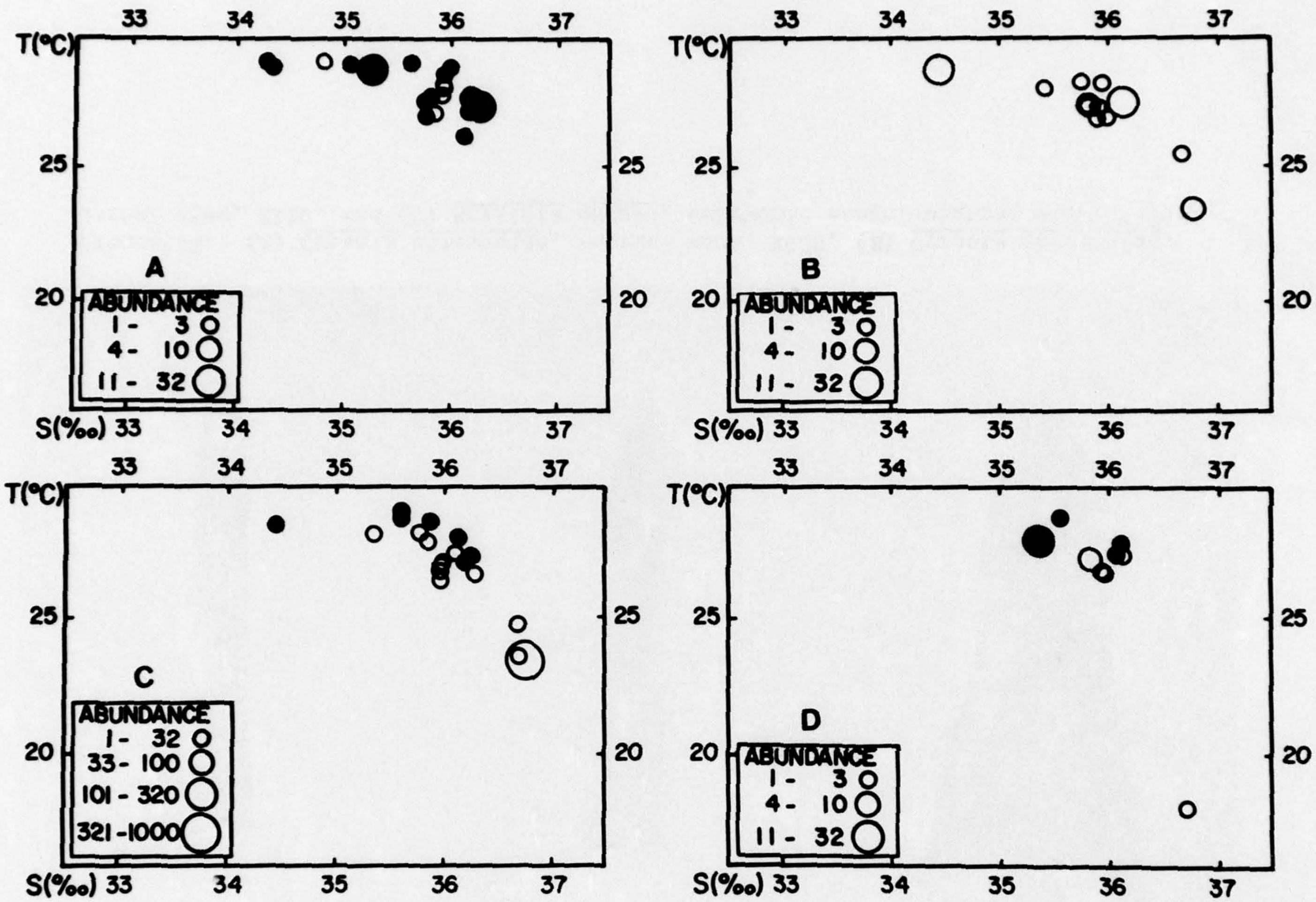

Figure 17. T-S-P diagrams, (A) the adults of _Creseis virgula_ f. _virgula_ (Open circles: day collections; solid circles: night collections), (B) the adults of _Creseis virgula_ f. _conica_ during the day, (C) the juveniles of _Creseis virgula_ f. _conica_ (Open circles: day collections; solid circles: night collections), and (D) _Creseis chierchiae_ (Open circles: day collections; solid circles: night collections).

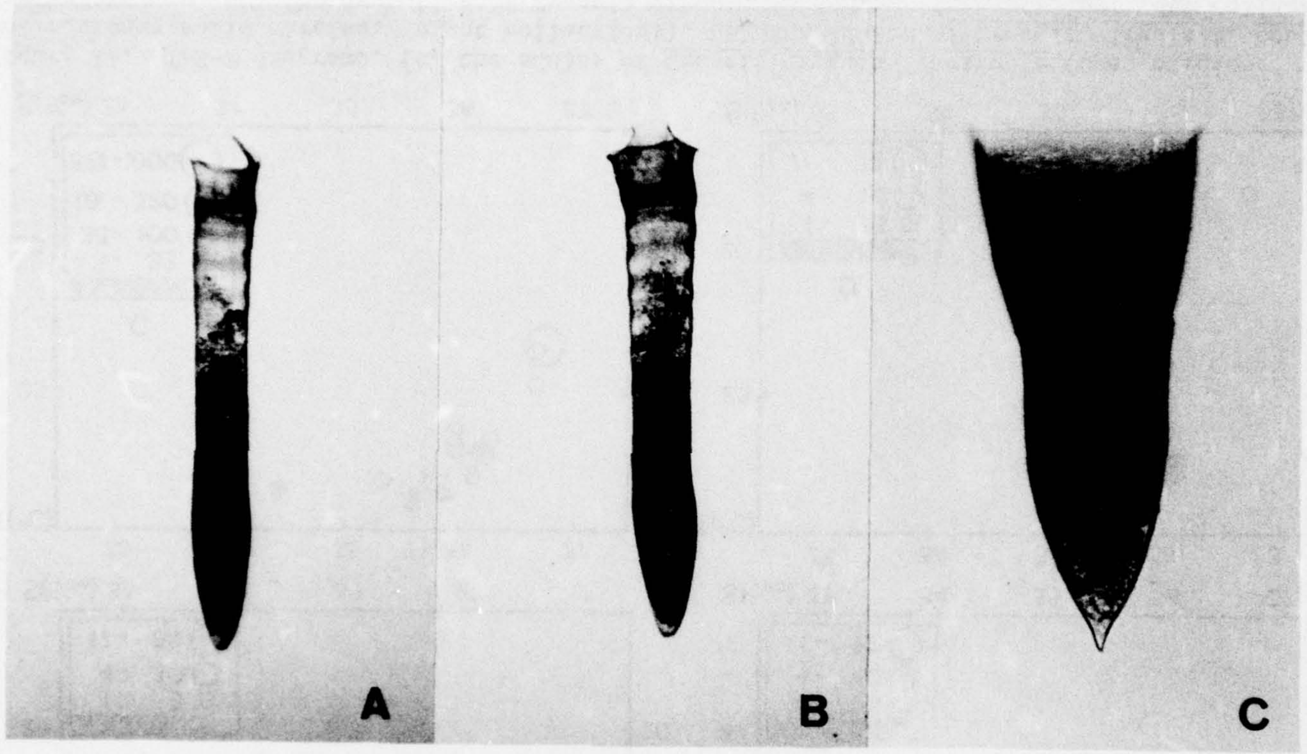

Figure 18. (A) Creseis chierchiae, lateral view, X120, (B) Creseis chierchiae, dorsal view, X120, and (C) Styliola subula, embryonic stage, ventral view, X300.

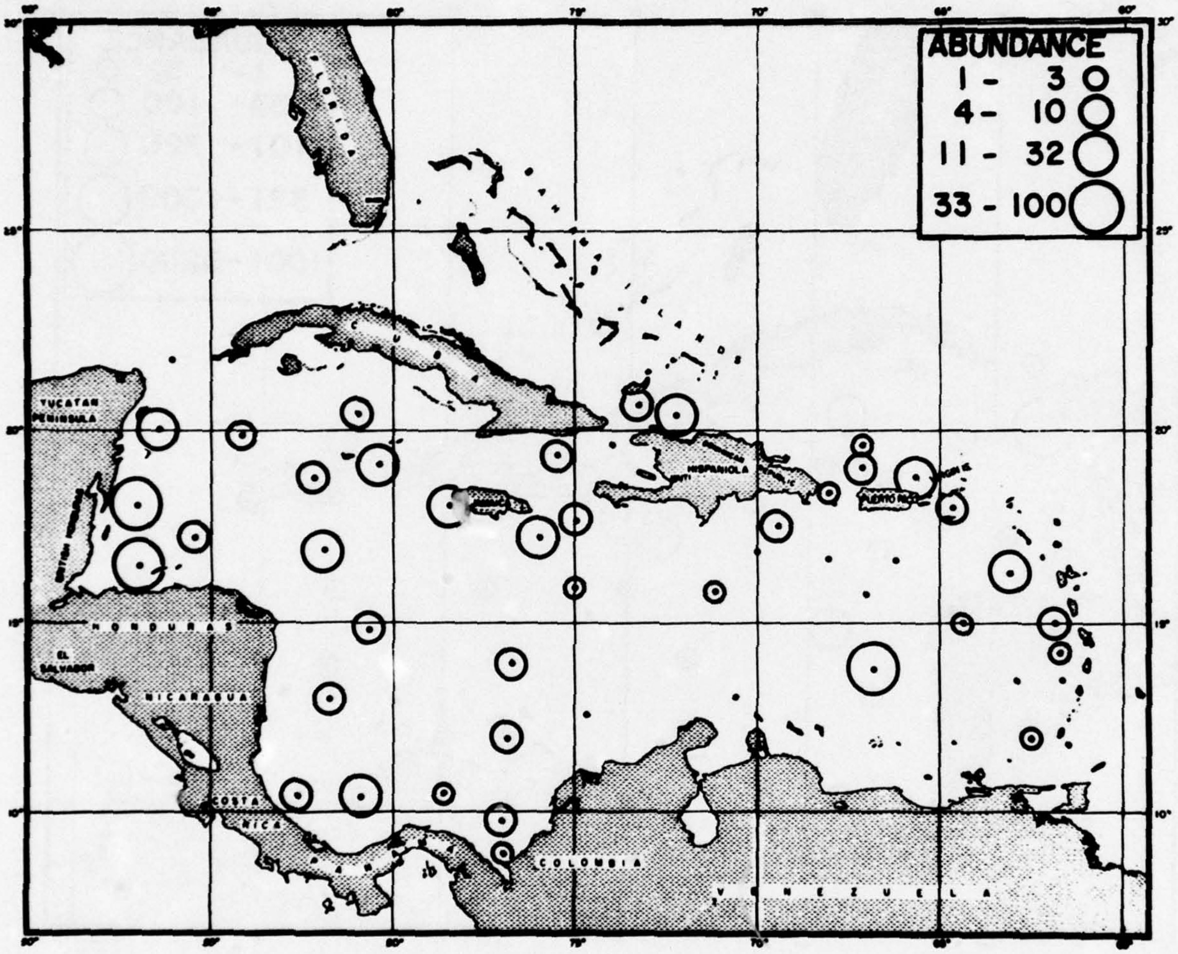

Figure 19. Horizontal distribution of the adults of Styliola subula.

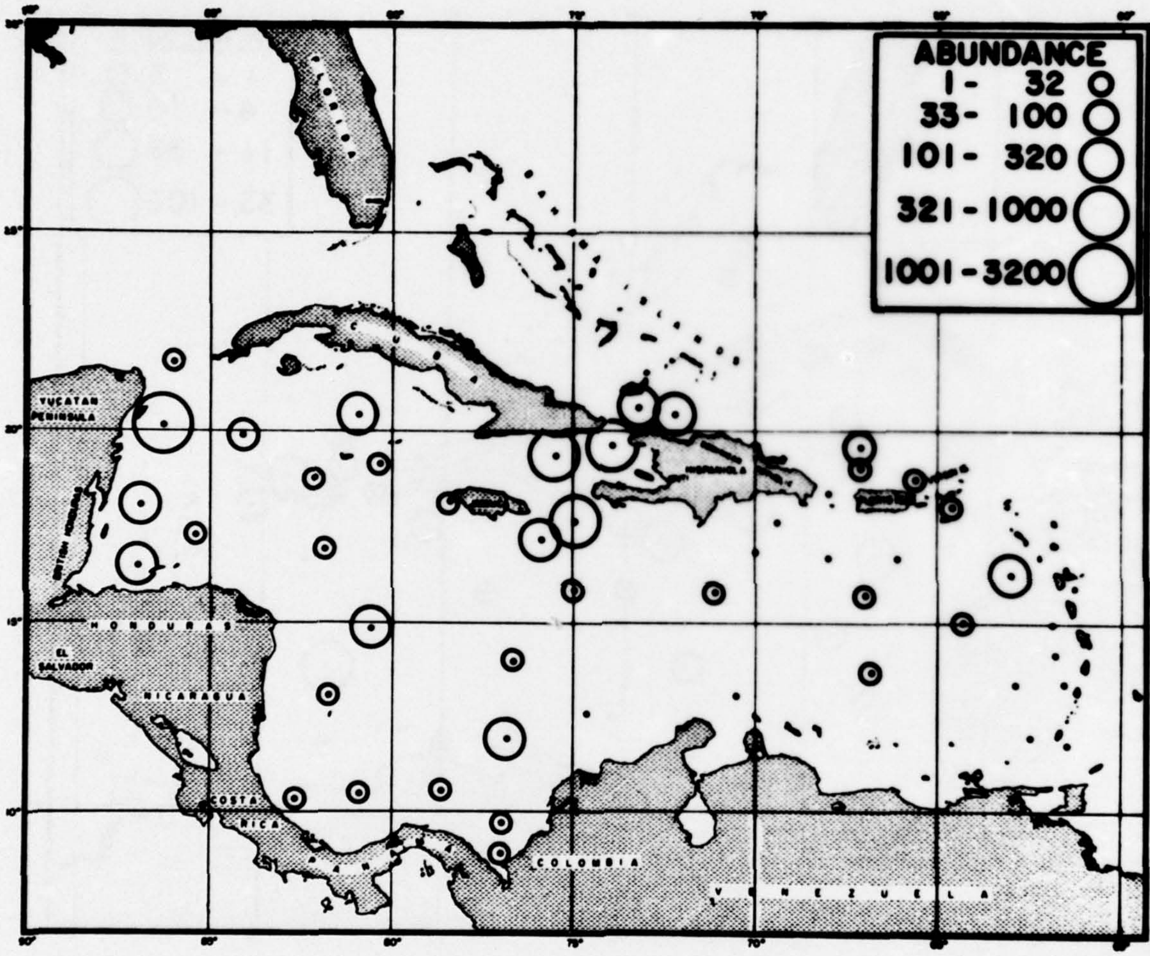

Figure 20. Horizontal distribution of the juveniles of Styliola subula.

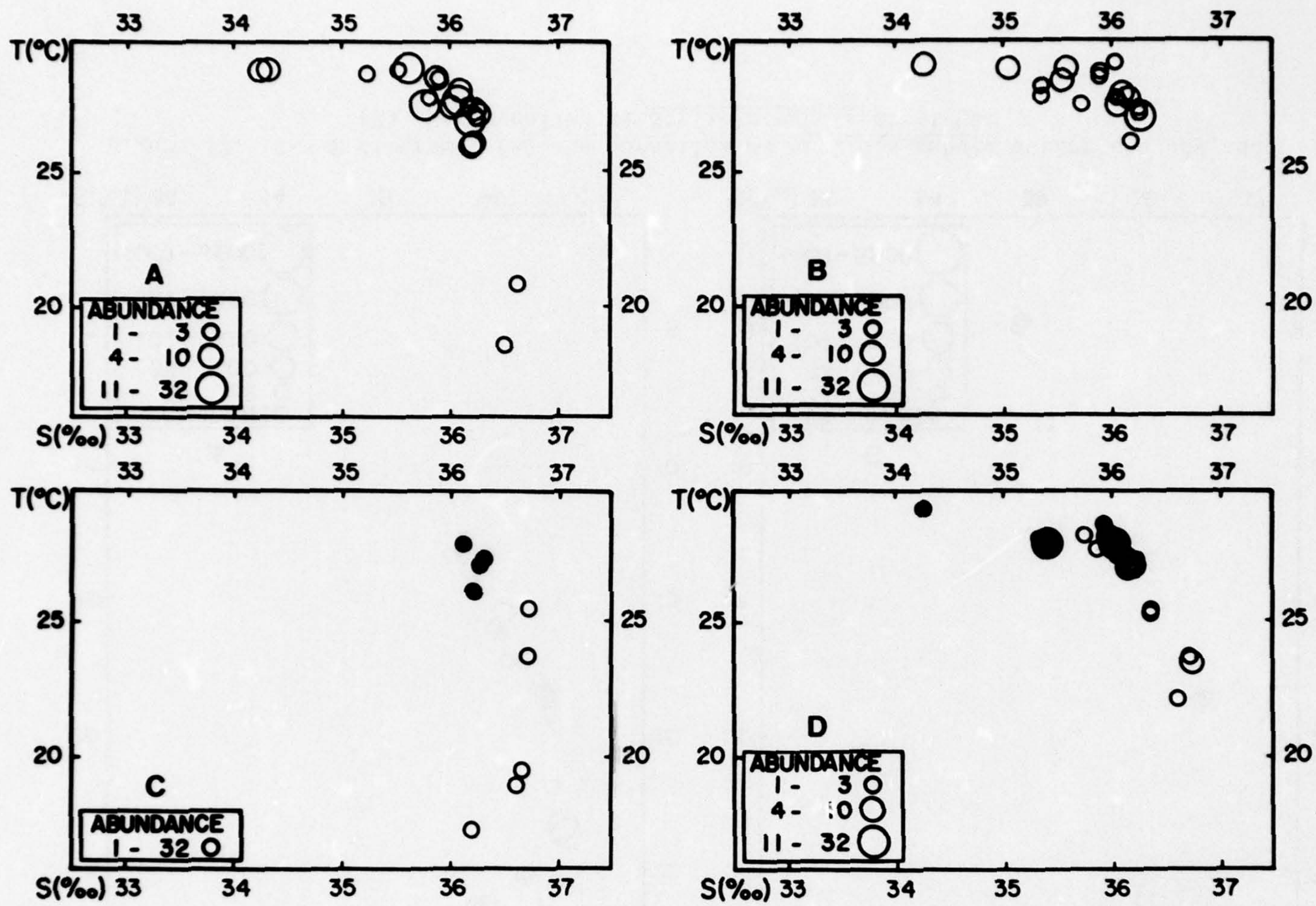

Figure 21. T-S-P diagrams, (A) the adults of Styliola subula at night, (B) the adults of Hyalocylis striata at night, (C) the juveniles of Hyalocylis striata (Open circles: day collections; solid circles: night collections), and (D) the adults of Diacria quadridentata (Open circles: day collections; solid circles: night collections).

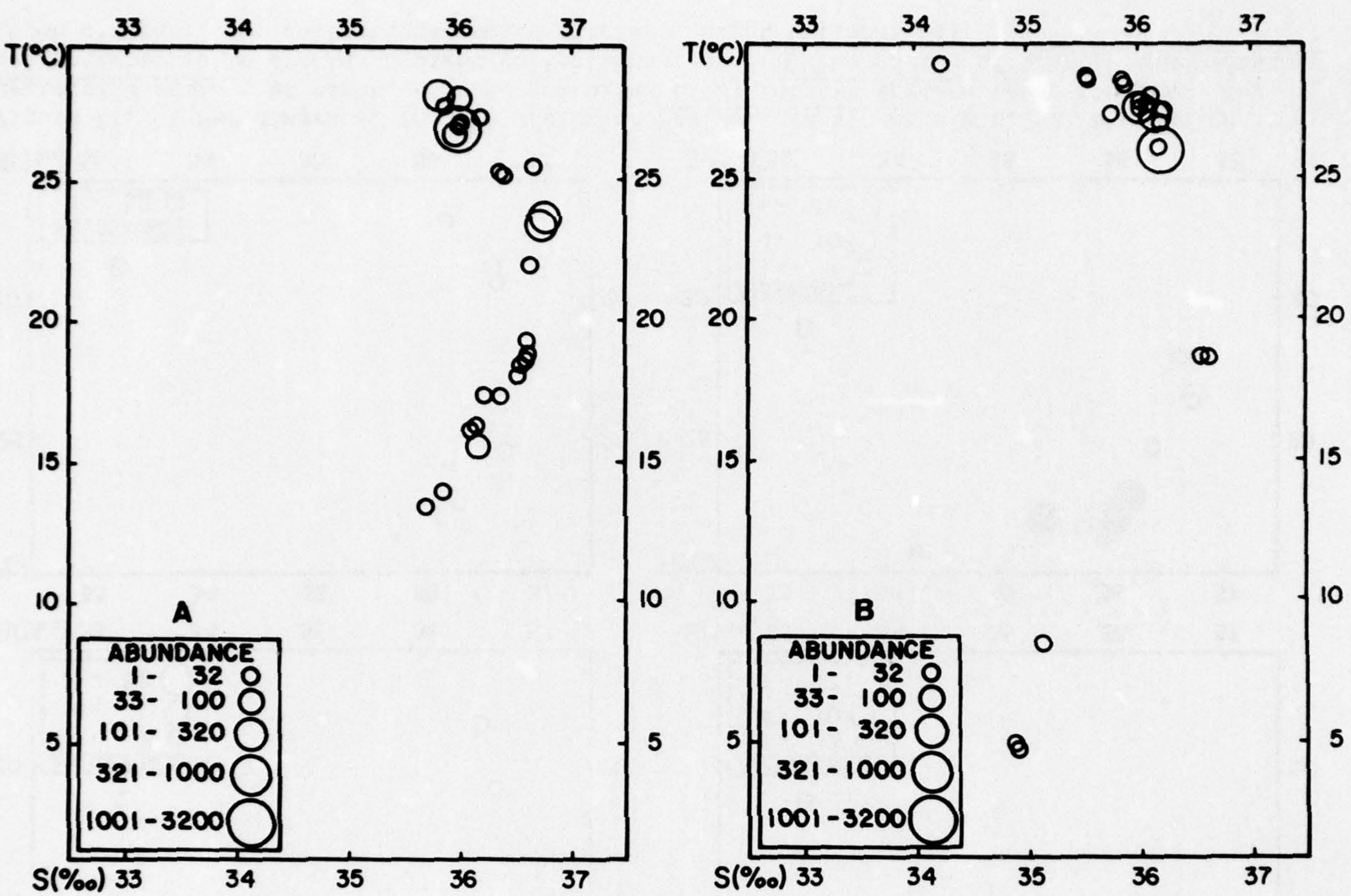

Figure 22. T-S-P diagrams, (A) the juveniles of <u>Styliola subula</u> during the day and (B) the juveniles of <u>Styliola subula</u> at night.

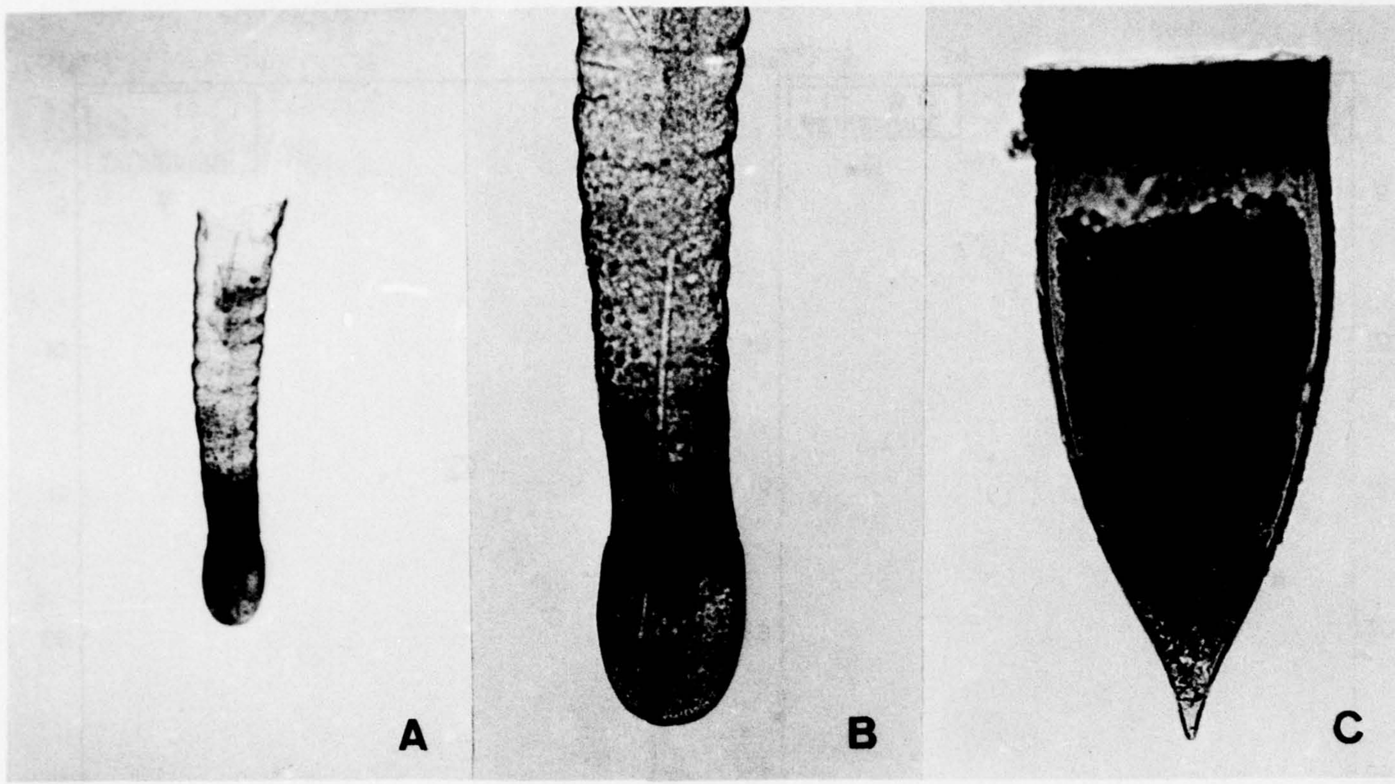

Figure 23. (A) Hyalocylis striata (?), empty shell, X120; (B) Hyalocylis striata (?), empty shell, X300; and (C) Clio pyramidata f. lanceolata, embryonic stage, dorsal. view, X300.

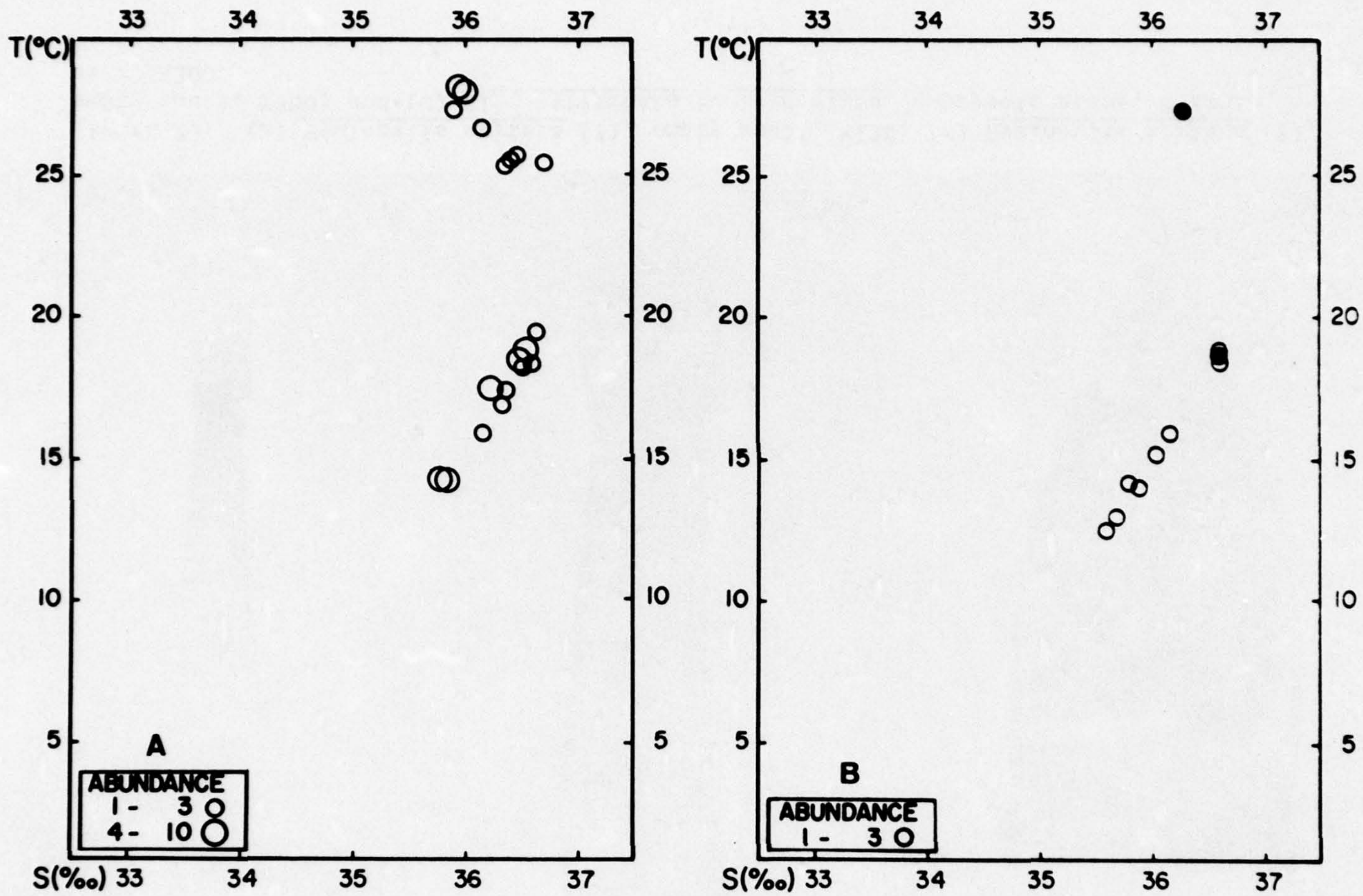

Figure 24. T-S-P diagrams, (A) the adults of <u>Hyalocylis striata</u> during the day and (B) the juveniles of <u>Clio pyramidata</u> f. <u>lanceolata</u> (Open circles: day collections; solid circles: night collections).

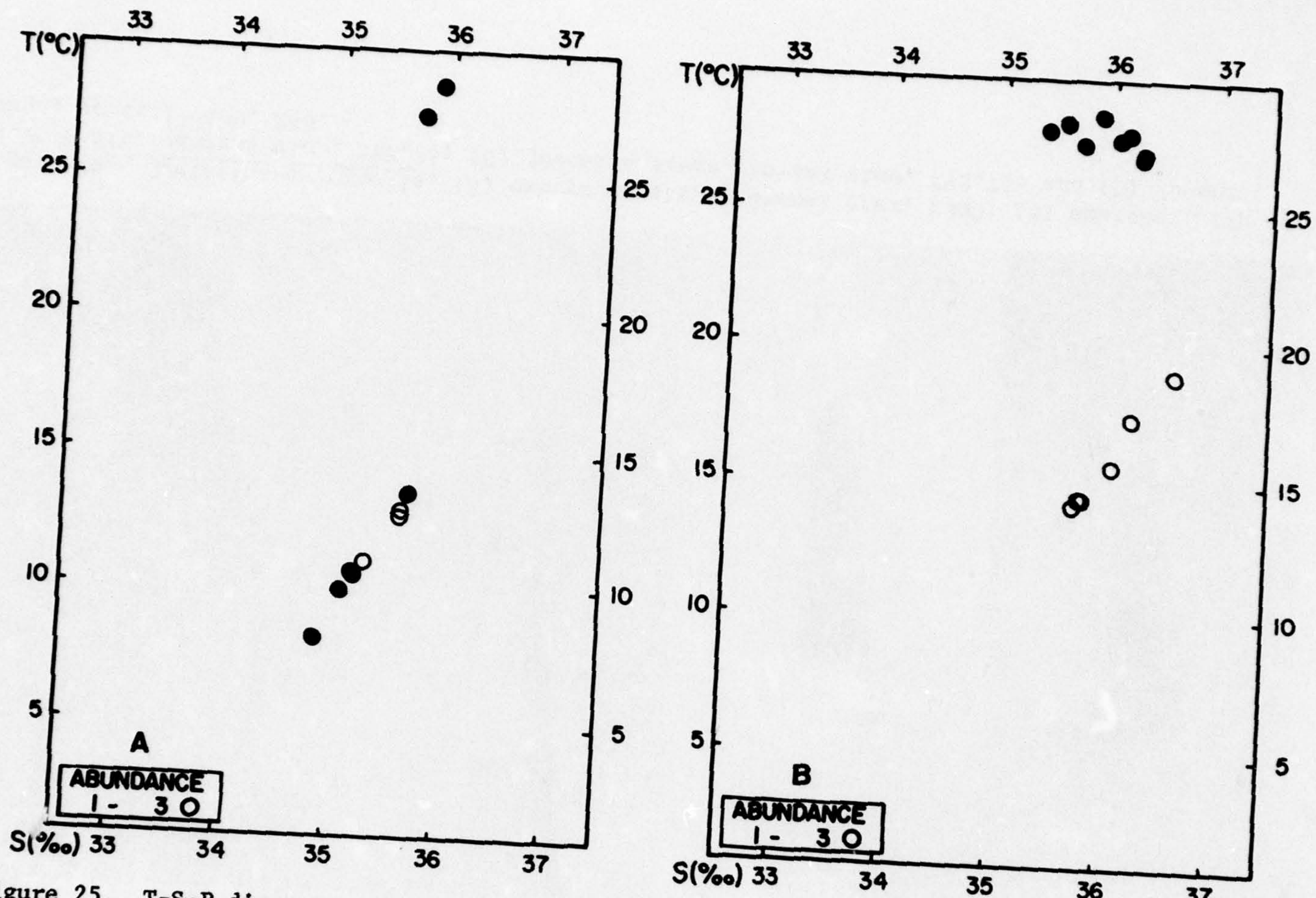

Figure 25. T-S-P diagrams, (A) the juveniles of Clio cuspidata (Open circles: day collections; solid circles: night collections) and (B) the adults of Cuvierina columnella (Open circles: day collections; solid circles: night collections).

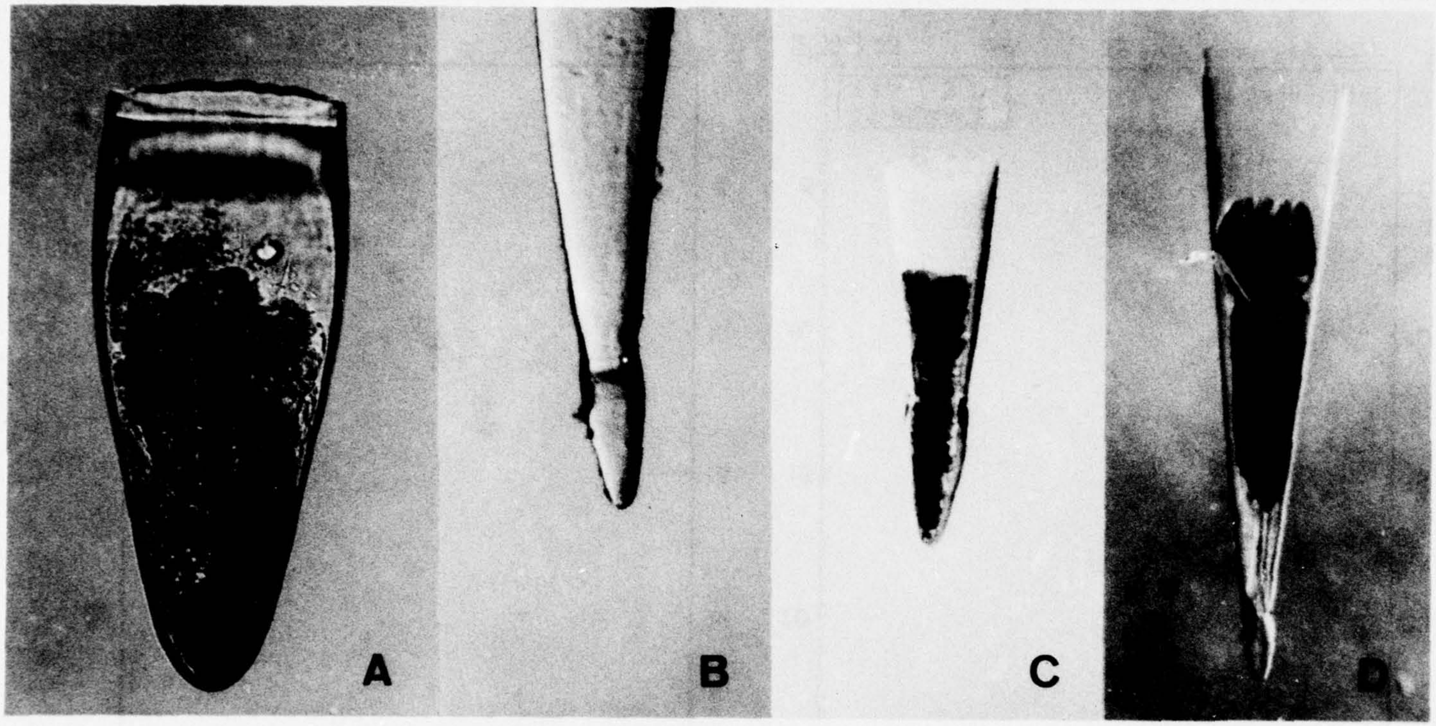

Figure 26. Cuvierina columnella, (A) embryonic stage, dorsal view, X300; (B) embryonic tip of adult shell, ventral view, X93.75; (C) juvenile stage, dorsal view, X93.75; and (D) juvenile stage, ventral view, X45.

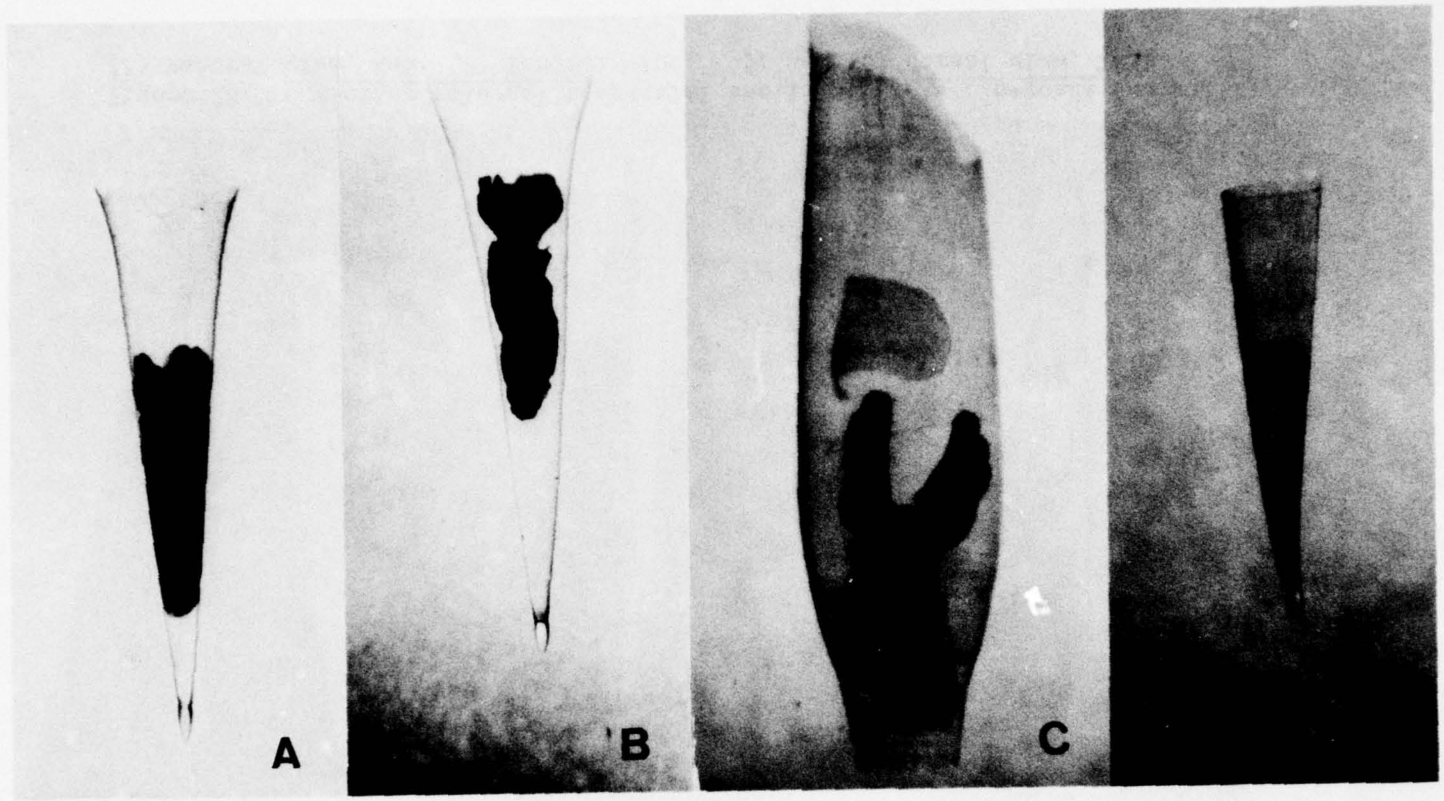

Figure 27. Cuvierina columnella, (A) juvenile stage, ventral view, X22.5; (B) juvenile stage, dorsal view, X22.5; (C) adult shell portion of adult stage, ventral view, X22.5; and (D) juvenile shell portion of adult stage, ventral view, X22.5.

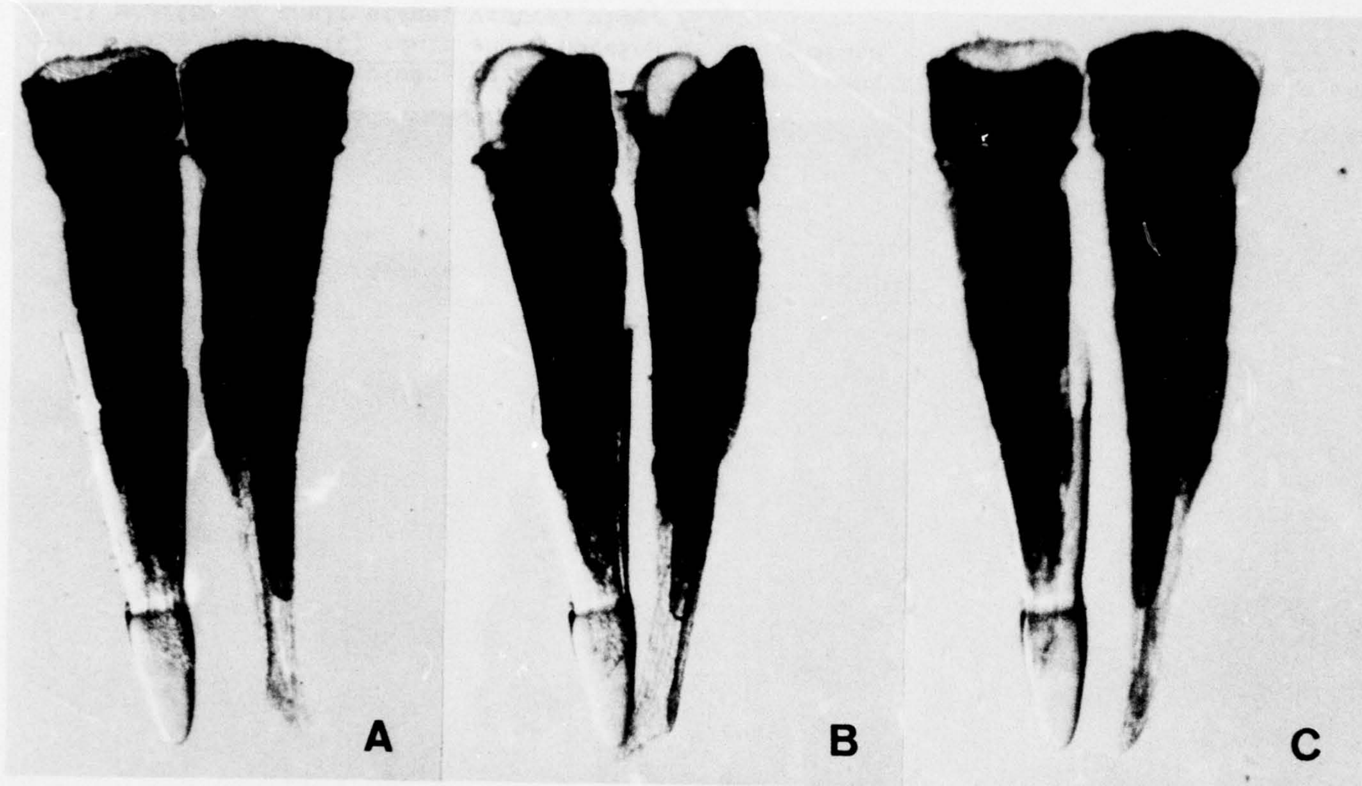

Figure 28. Cuvierina columnella (partial shell) Styliola sinecosta (no shell), (A) ventral view, X45; (B) lateral view, X45; and (C) dorsal view, X45.

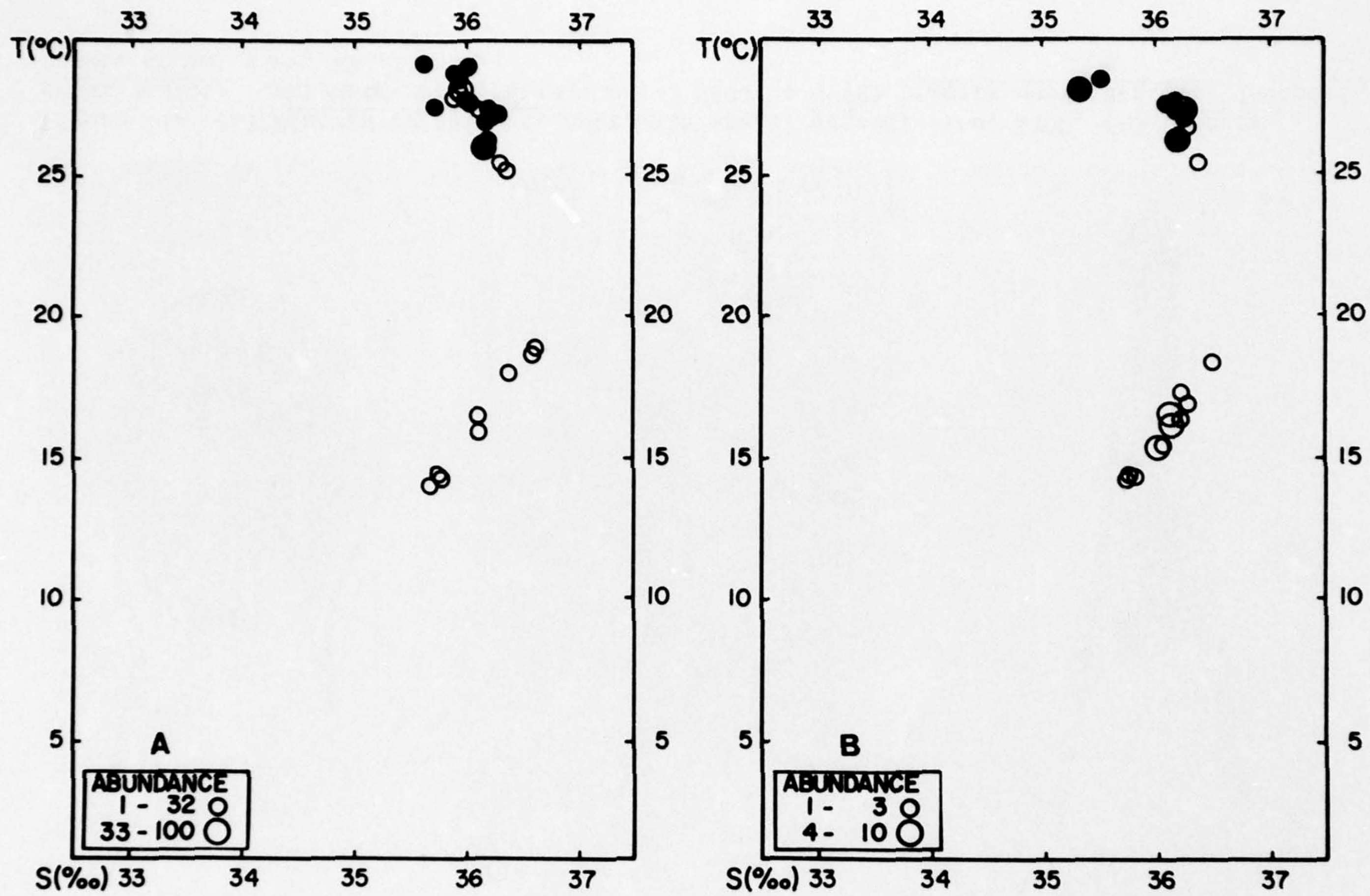

Figure 29. T-S-P diagrams, (A) the juveniles of Cuvierina columnella (Open circles: day collections; solid circles: night collections) and (B) the adults of Diacria trispinosa (Open circles: day collections; solid circles: night collections).

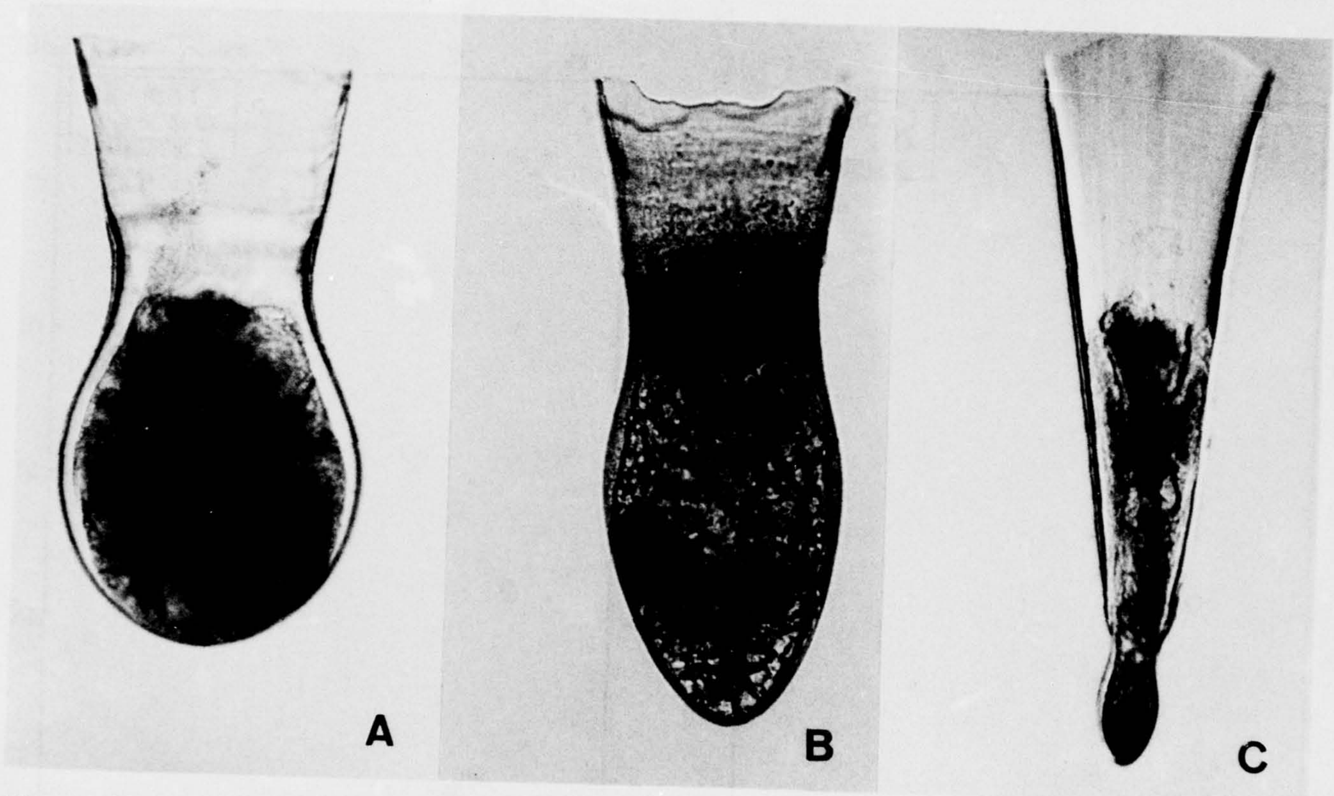

Figure 30. (A) Diacria trispinosa, embryonic stage, ventral view, X300; (B) Diacria quadridentata, embryonic stage, dorsal view, X300; and (C) Diacria quadridentata, juvenile stage, dorsal view, X93.75.

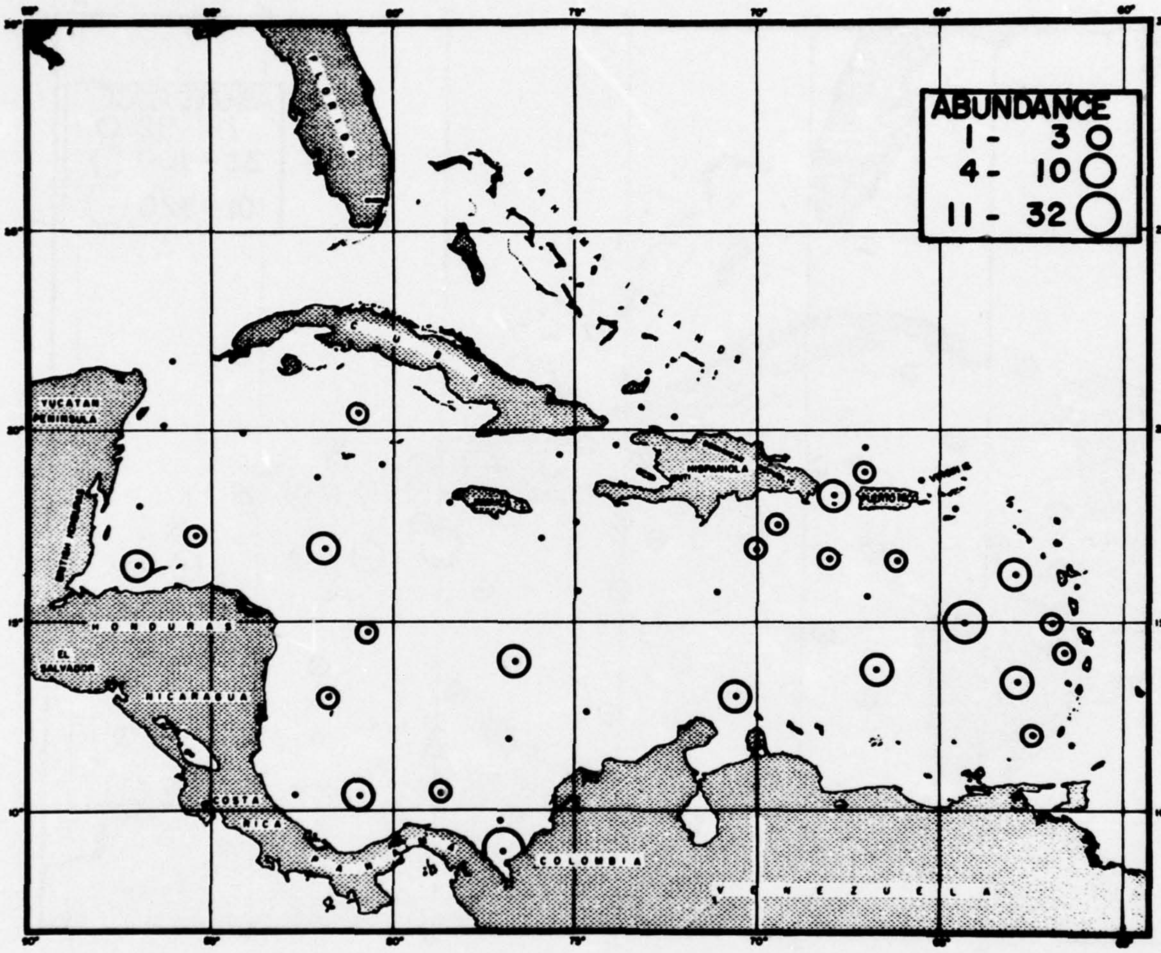

Figure 31. Horizontal distribution of the adults of Diacria trispinosa.

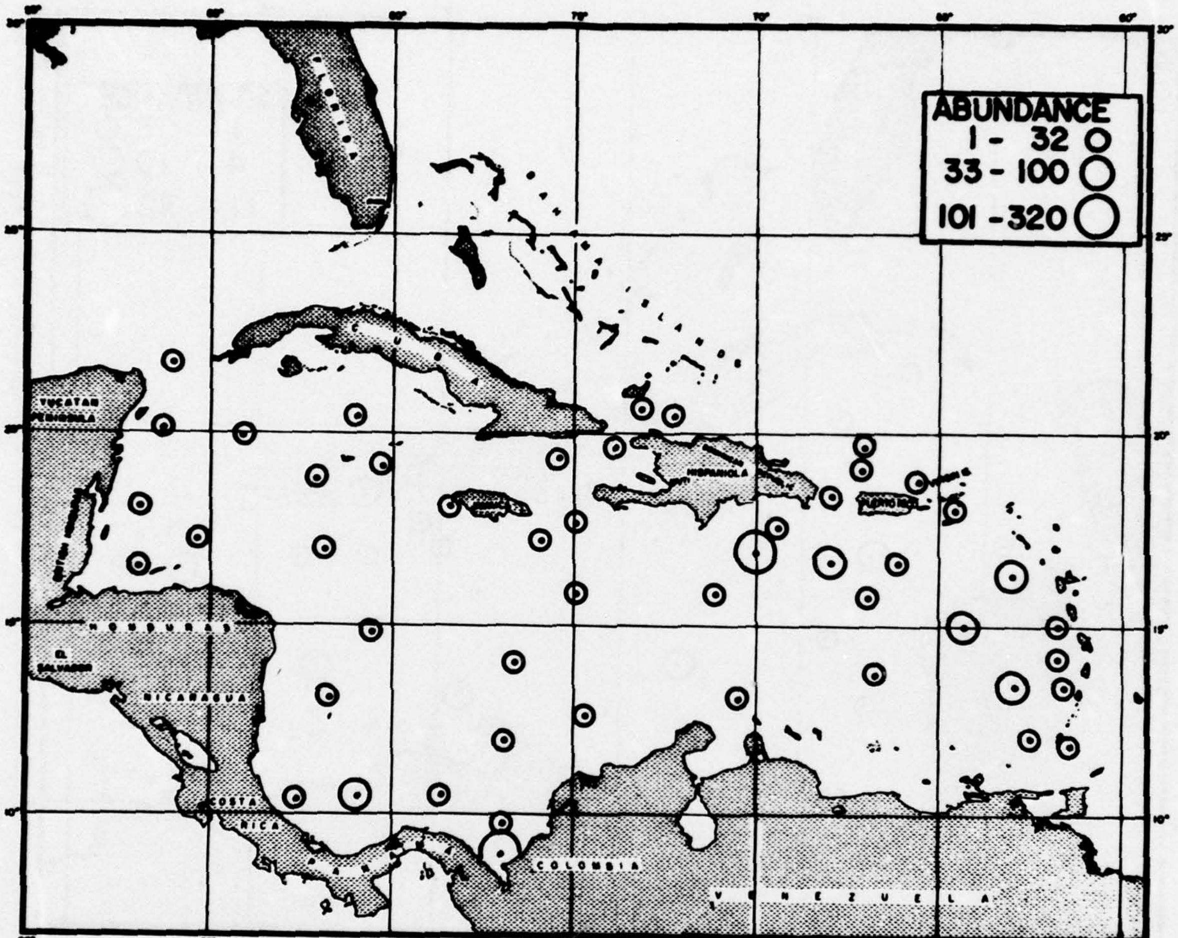

Figure 32. Horizontal distribution of the juveniles of Diacria trispinosa.

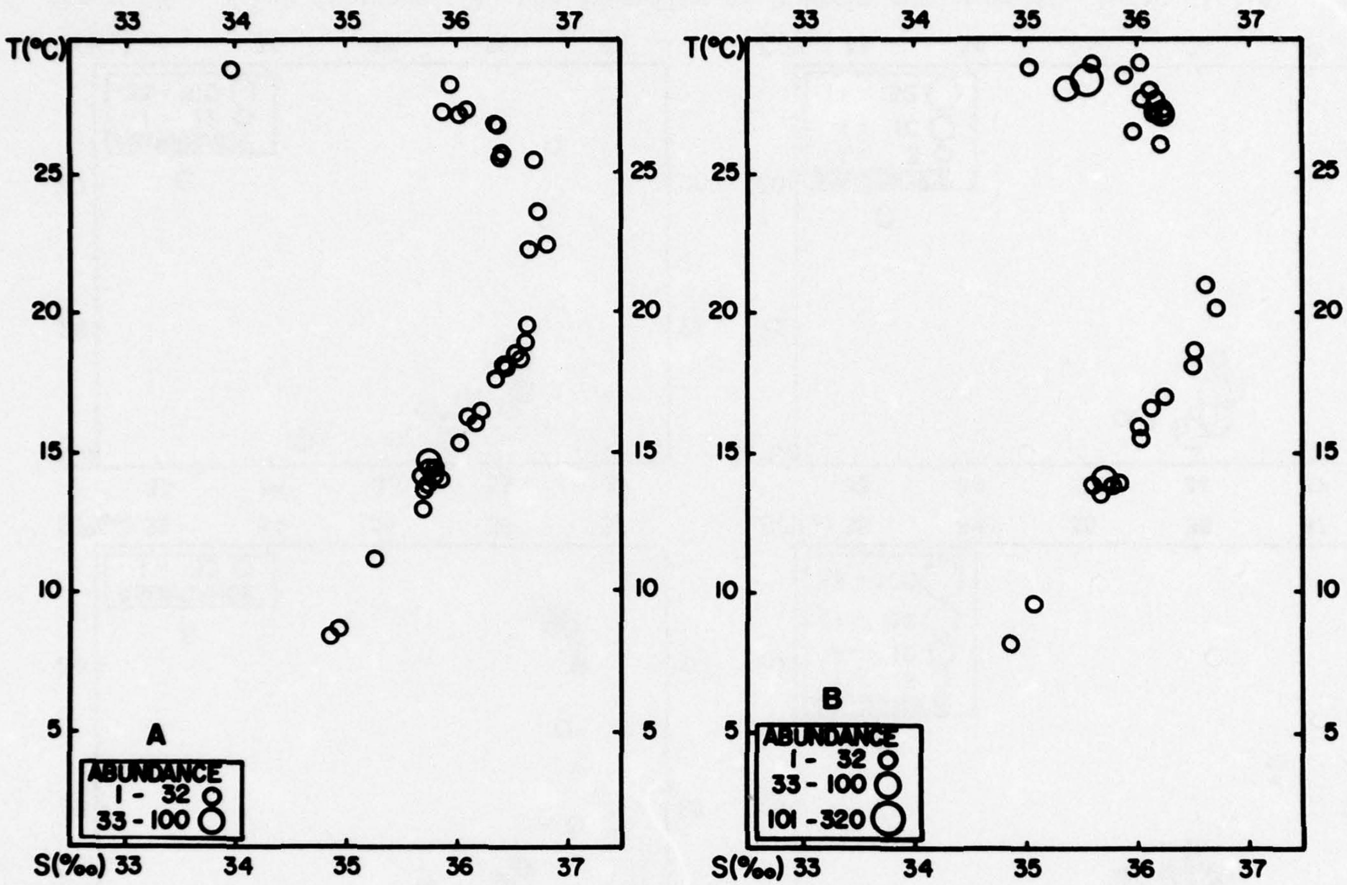

Figure 33. T-S-P diagrams, (A) the juveniles of _Diacria trispinosa_ during the day and (B) the juveniles of _Diacria trispinosa_ at night.

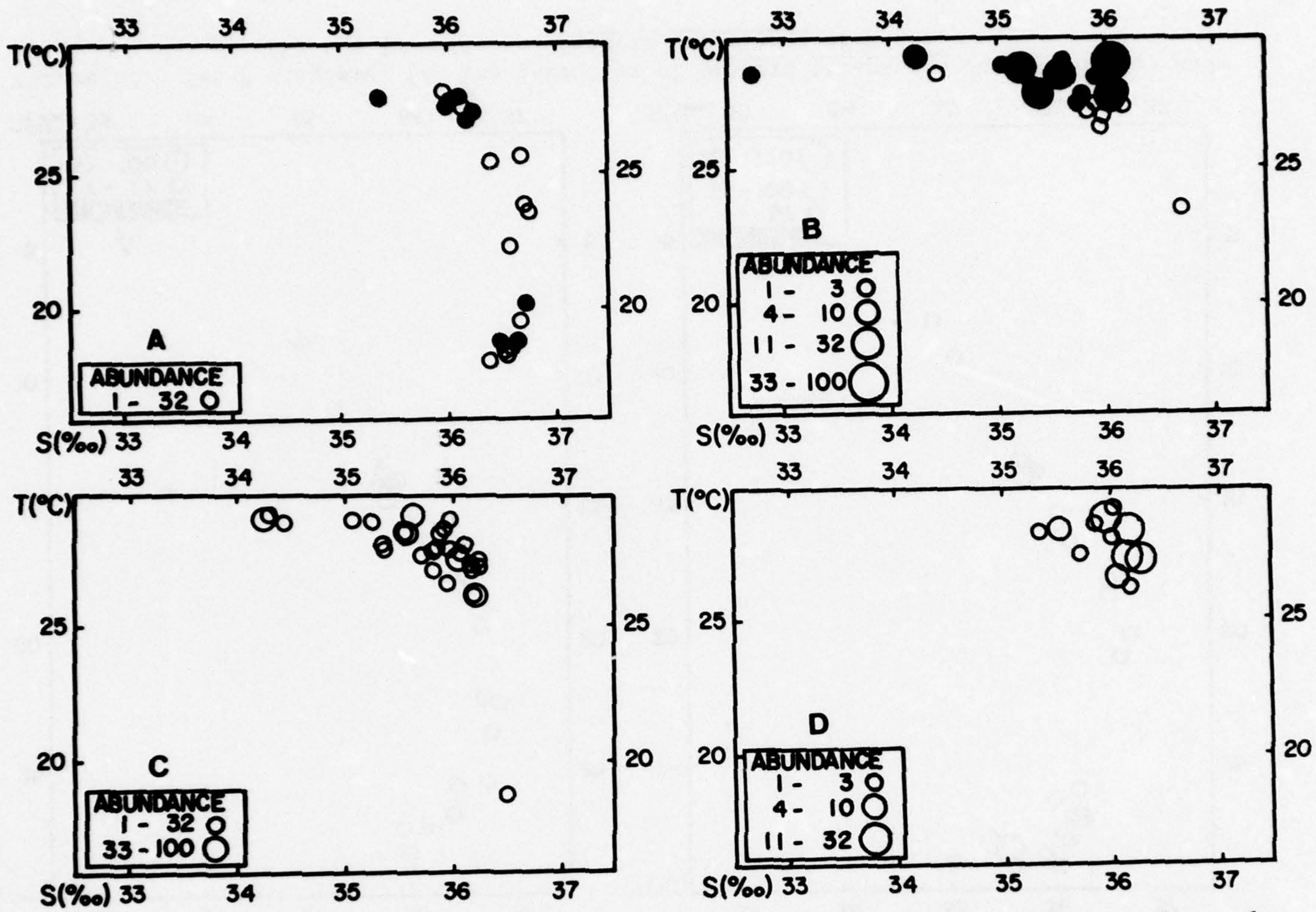

Figure 34. T-S-P diagrams, (A) the juveniles of <u>Diacria quadridentata</u> (Open circles: day collections; solid circles: night collections), (B) the adults of <u>Cavolinia longirostris</u> f. <u>longirostris</u> (Open circles: day collections; solid circles: night collections), (C) the juveniles of <u>Cavolinia longirostris</u> at night, and (D) <u>Cymbulia</u> sp. at night.

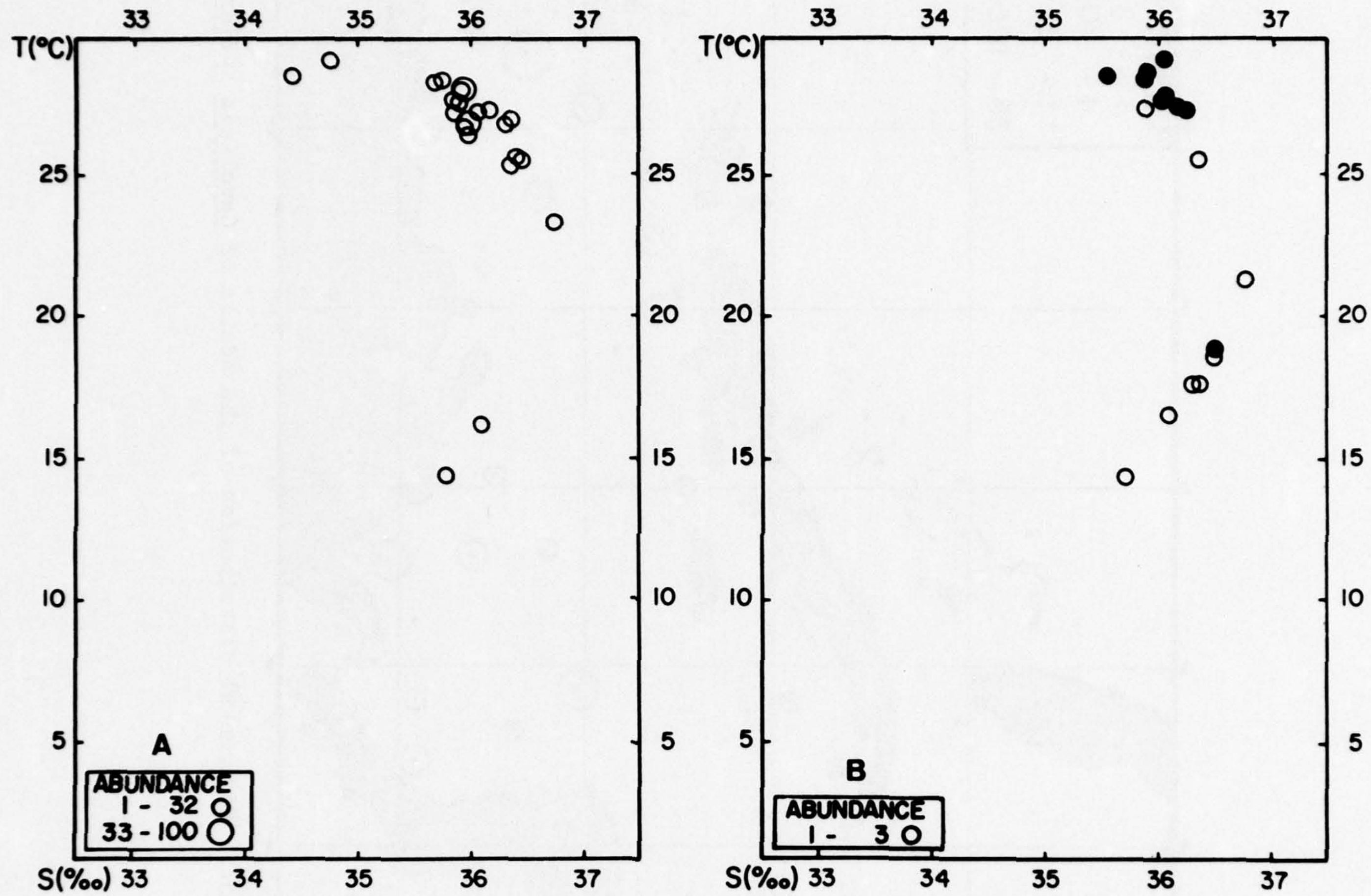

Figure 35. T-S-P diagrams, (A) the juveniles of *Cavolinia longirostris* during the day and (B) the adults of *Cavolinia uncinata* (Open circles: day collections; solid circles: night collections).

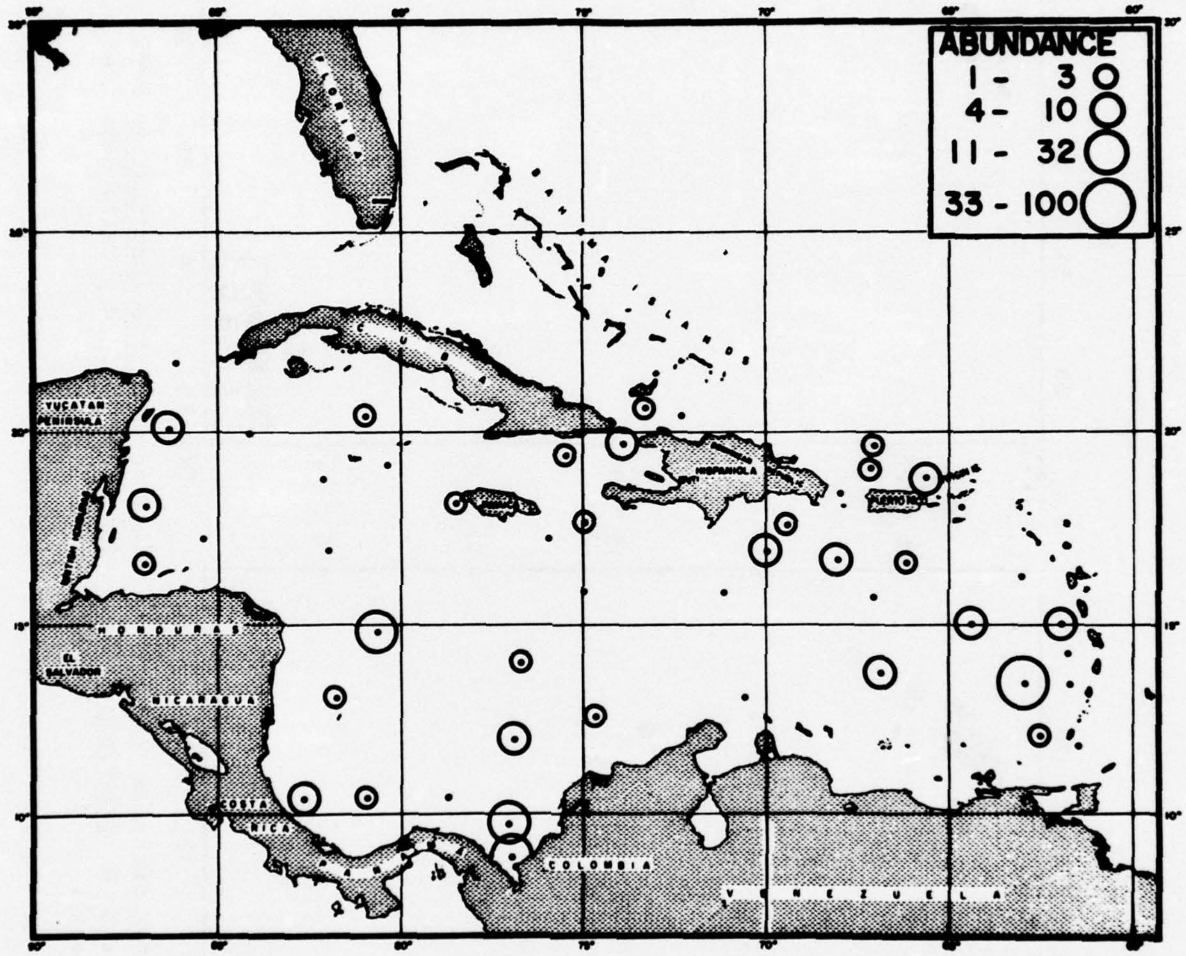

Figure 36. Horizontal distribution of the adults of Cavolinia inflexa.

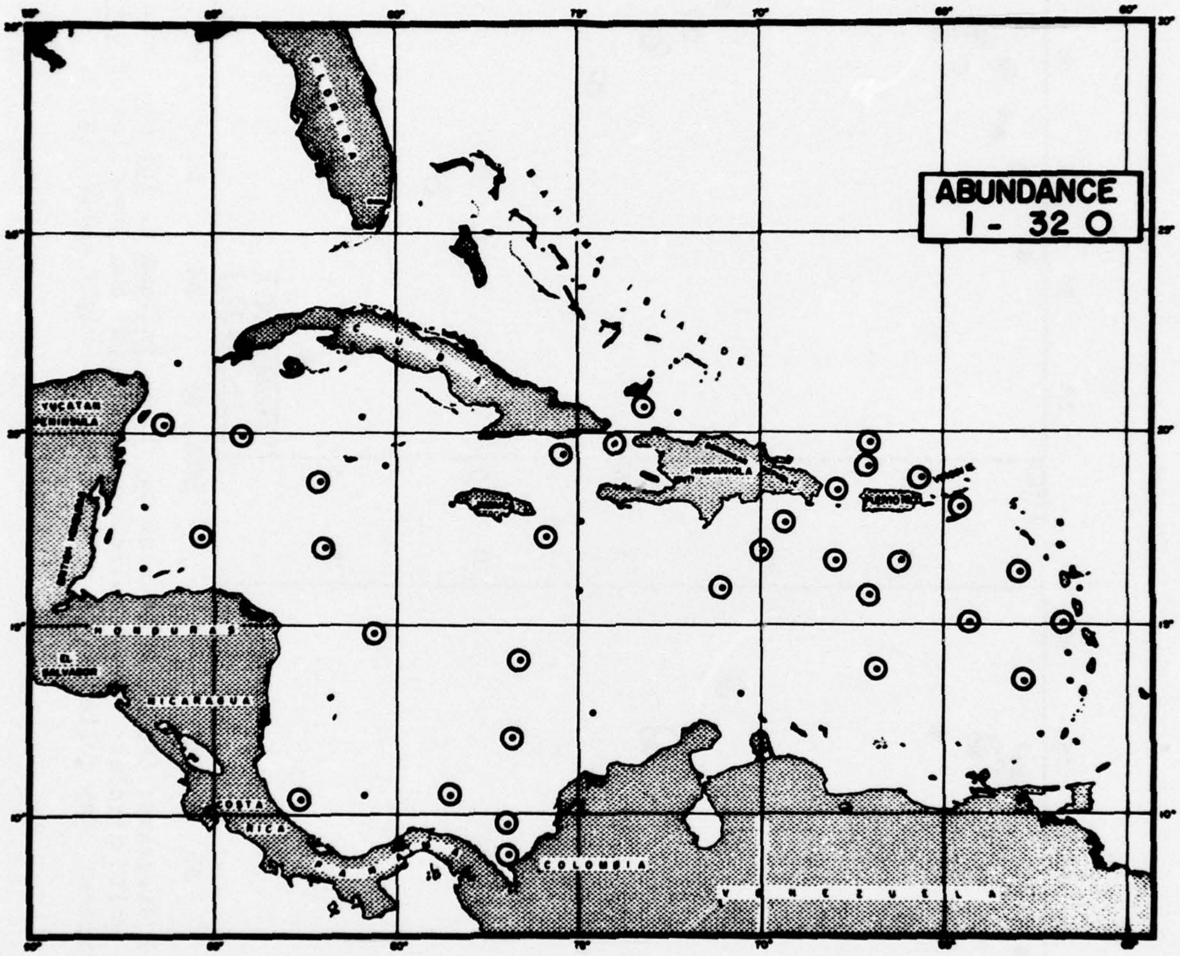

Figure 37. Horizontal distribution of the juveniles of Cavolinia inflexa.

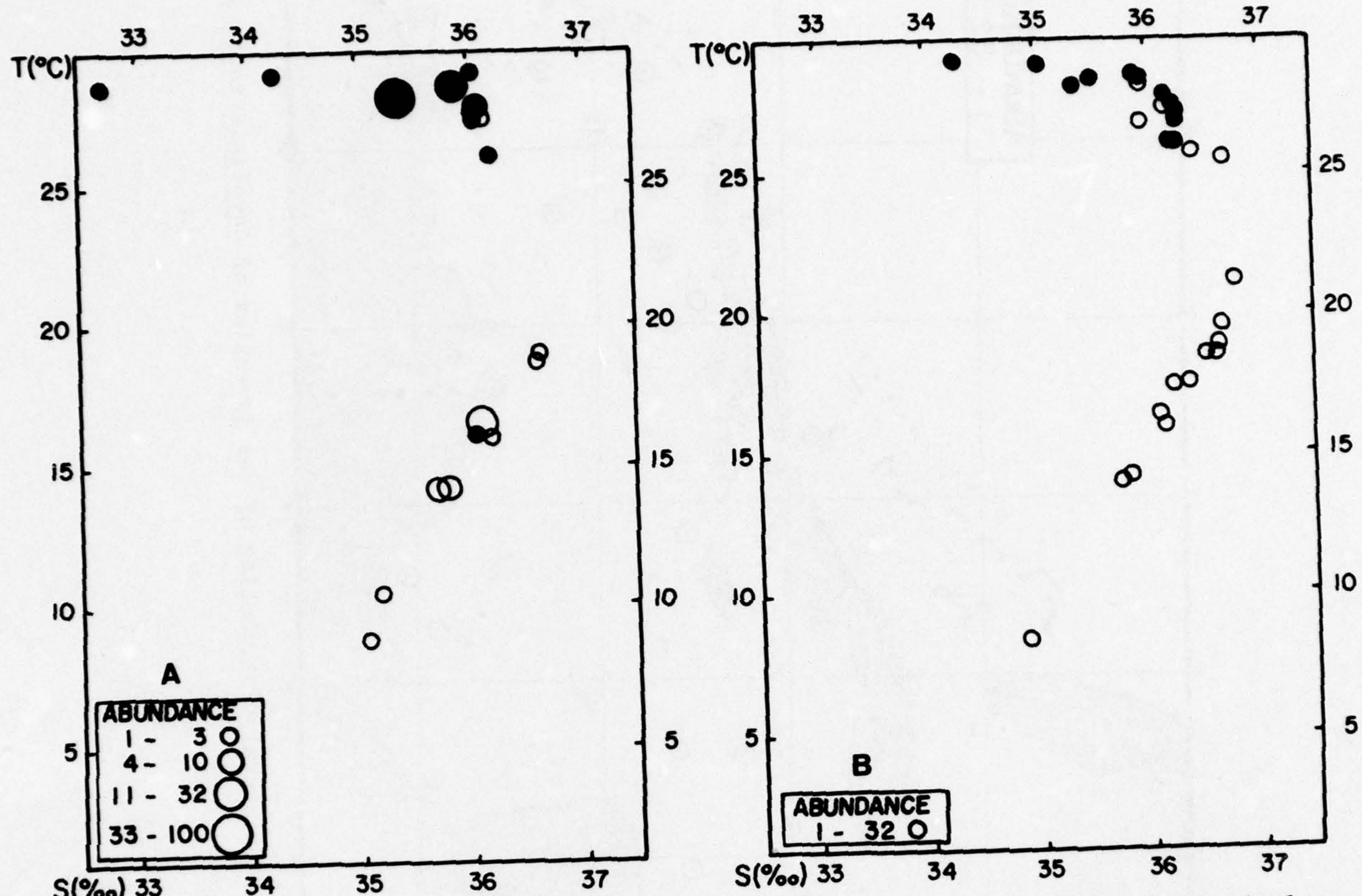

Figure 38. T-S-P diagrams, (A) the adults of Cavolinia inflexa f. inflexa (Open circles: day collections; solid circles: night collections) and (B) the juveniles of Cavolinia inflexa (Open circles: day collections; solid circles: night collections).

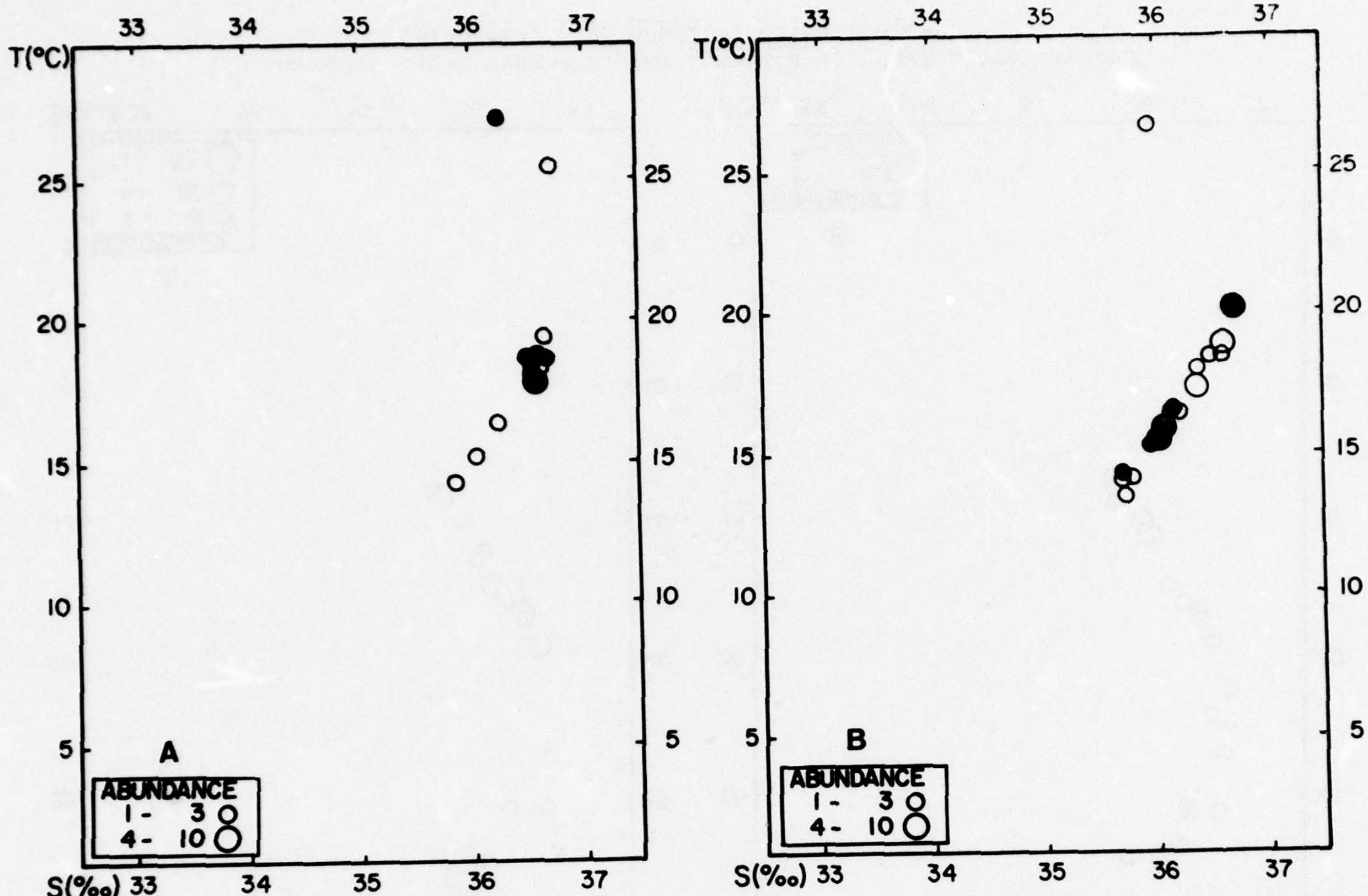

Figure 39. T-S-P diagrams, (A) <u>Peraclis bispinosa</u> (Open circles: day collections; solid circles: night collections) and (B) <u>Peraclis apicifulva</u> (Open circles: day collections; solid circles: night collections).

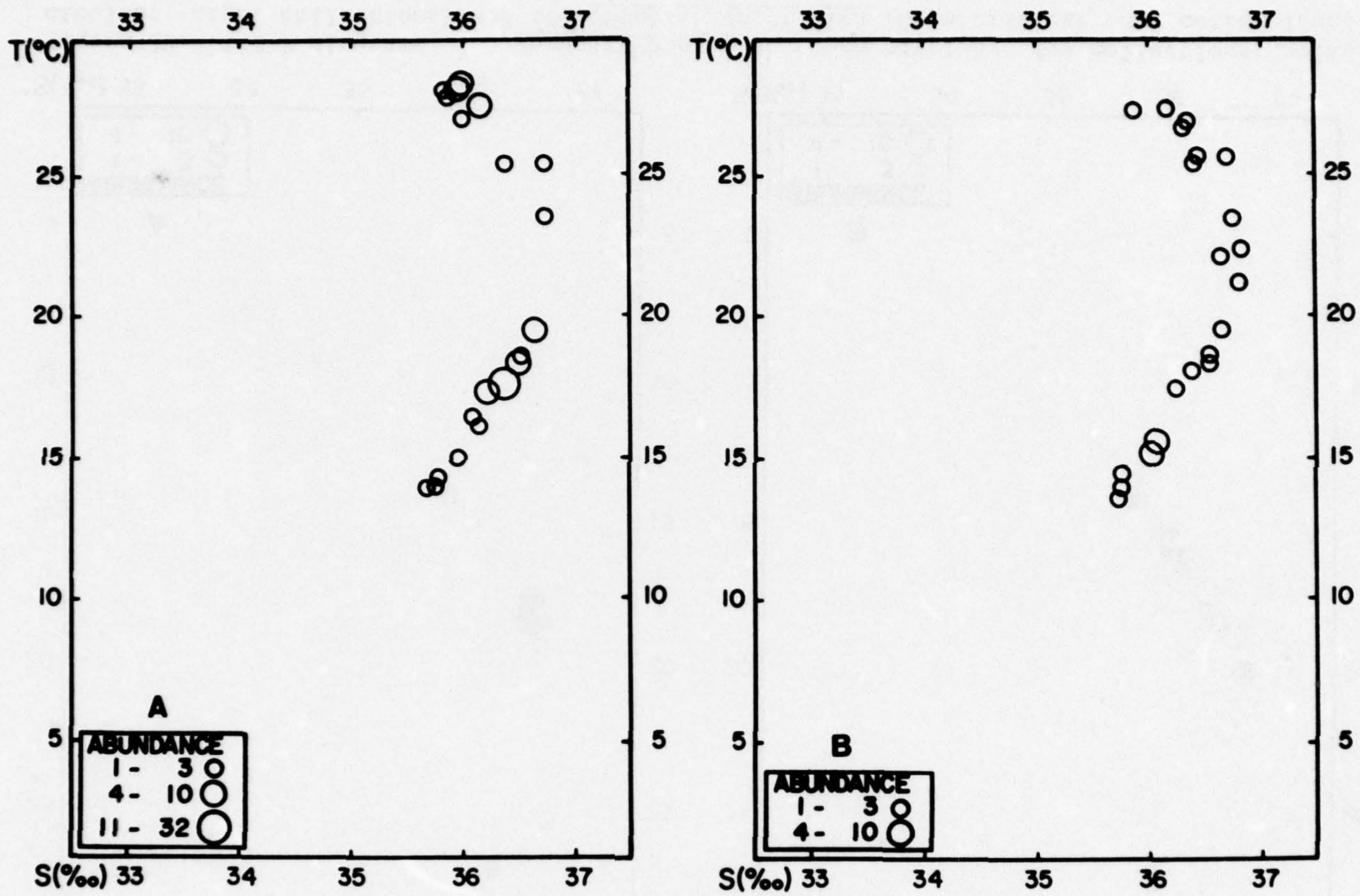

Figure 40. T-S-P diagrams, (A) *Cymbulia* sp. during the day and (B) *Desmopterus papilio* during the day.

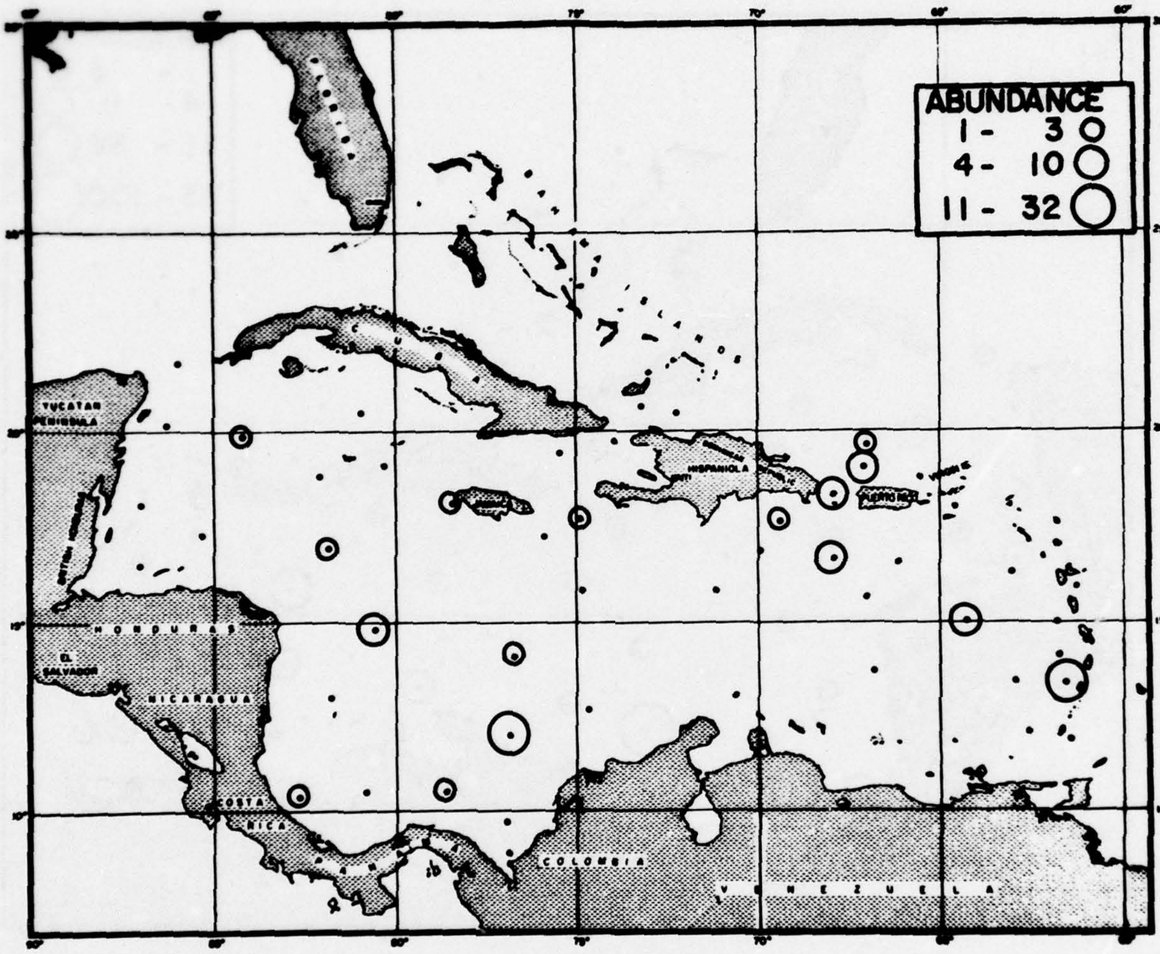

Figure 41. Horizontal distribution of Corolla spp.

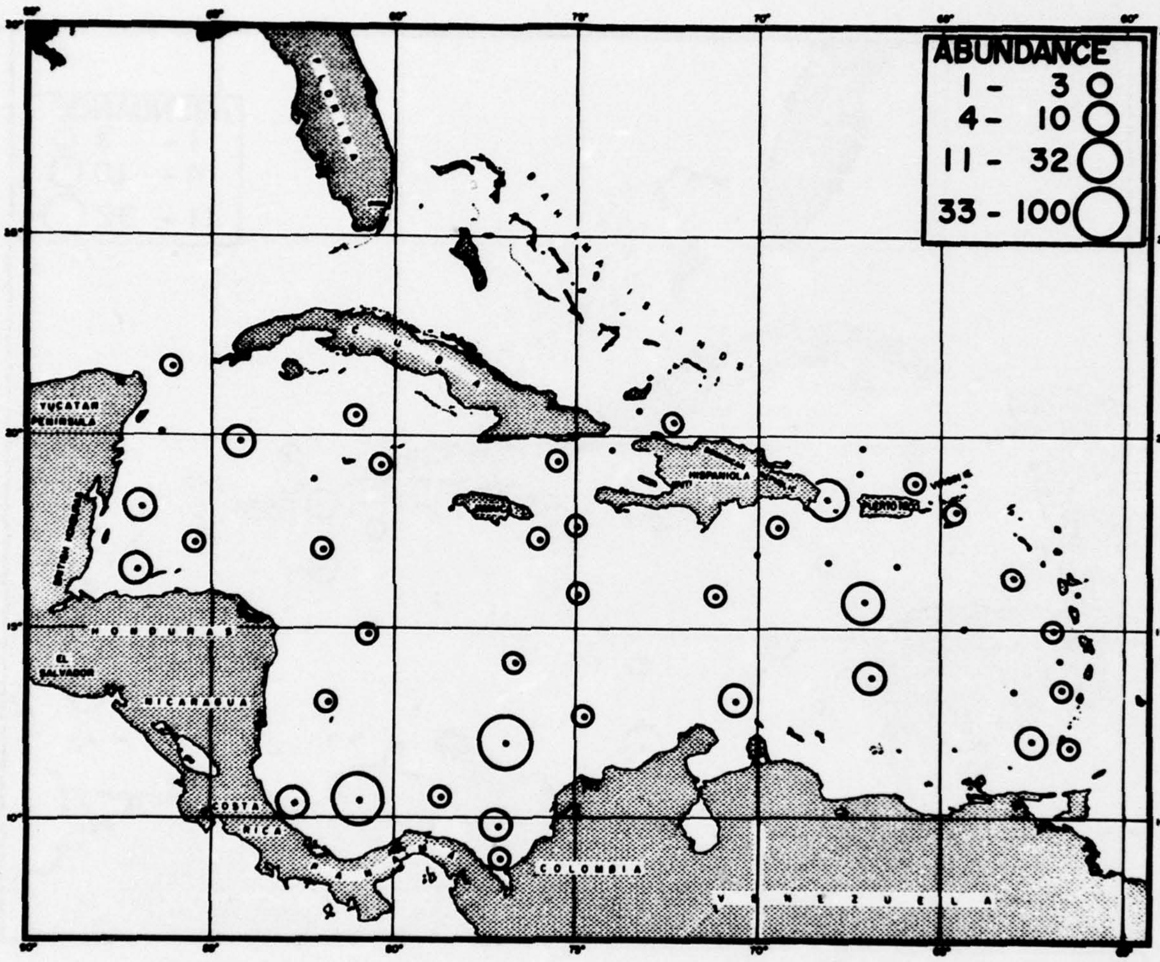

Figure 42. Horizontal distribution of Desmopterus papilio.

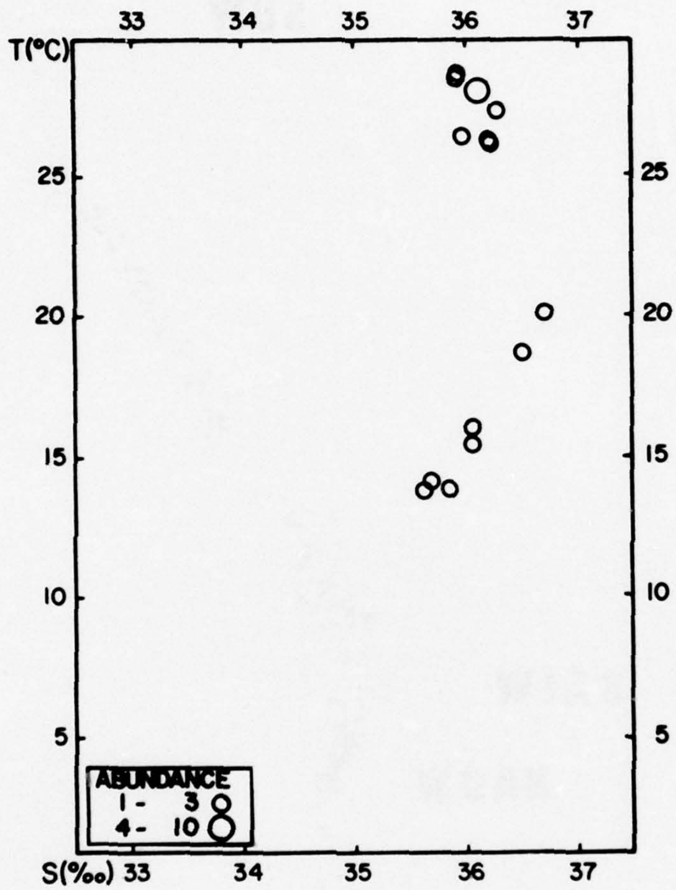

Figure 43. T-S-P diagram of Desmopterus papilio at night.

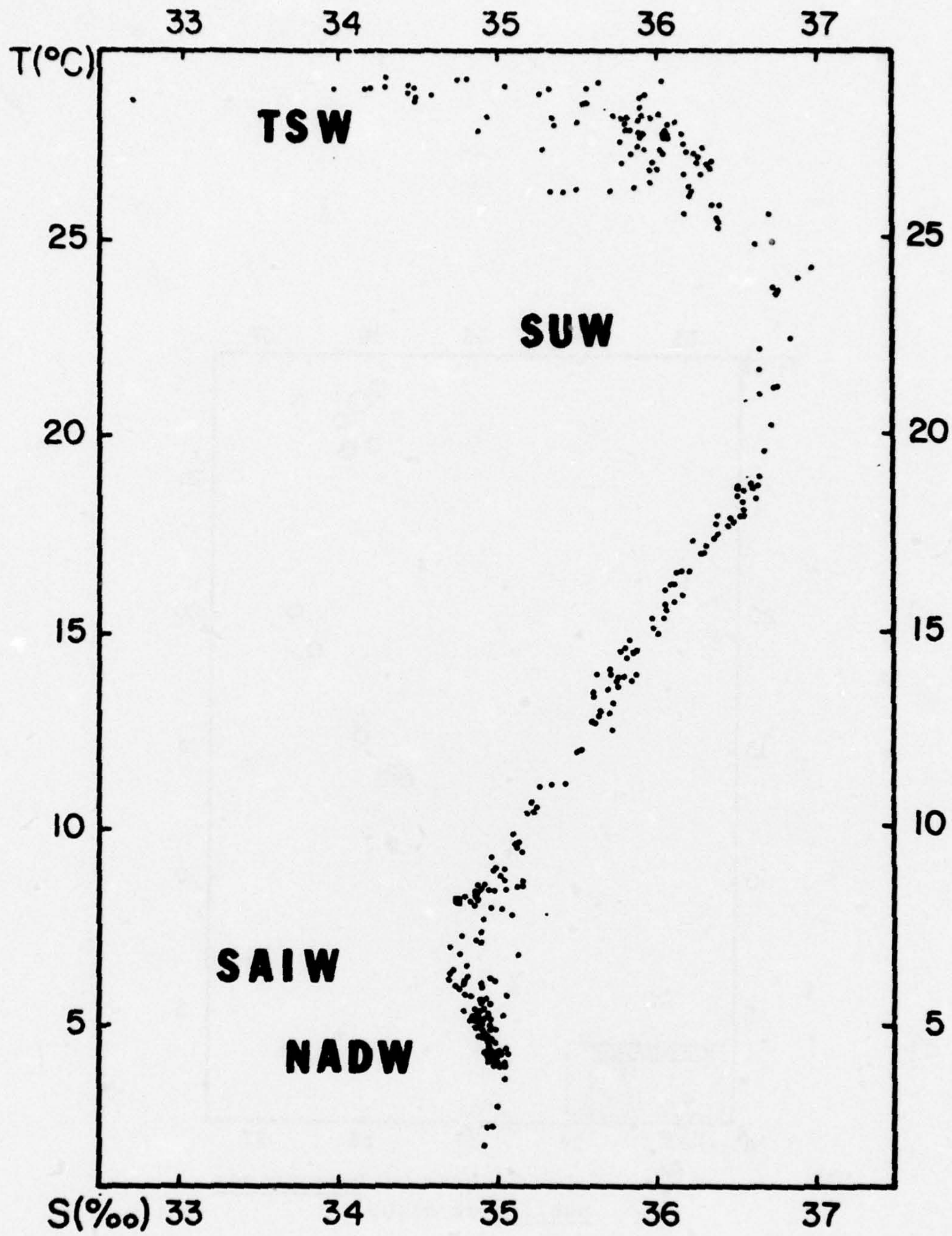

Figure 44. Temperatures and salinities measured quasi-synoptically at the depths of planktonic sampling. TSW: Tropical Surface Water Mass: SUW: Subtropical Underwater Mass; SAIW: Subantarctic Intermediate Water Mass; NADW: North Atlantic Deep Water Mass.

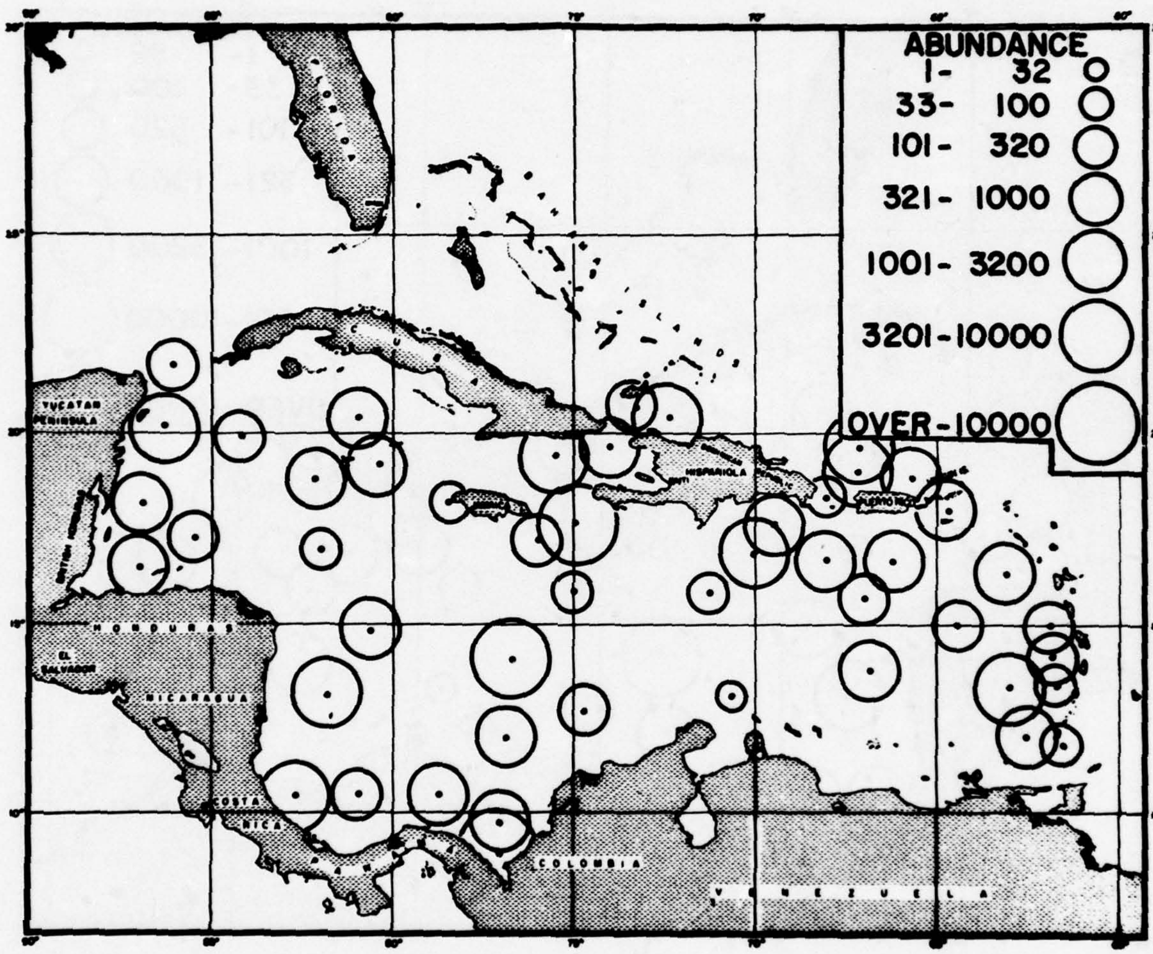

Figure 45. Horizontal distribution of total Thecosomata.

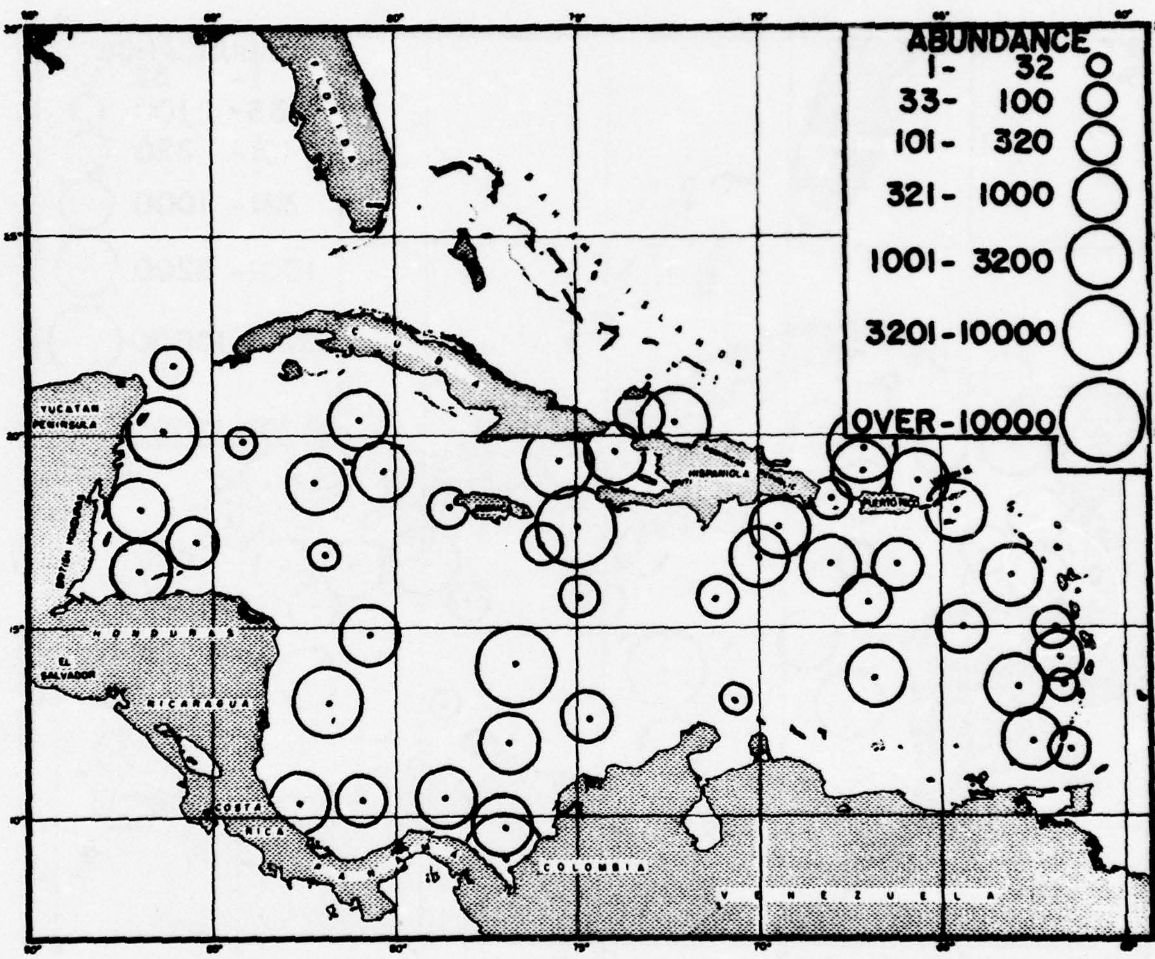

Figure 46. Horizontal distribution of total juvenile Euthecosomata.

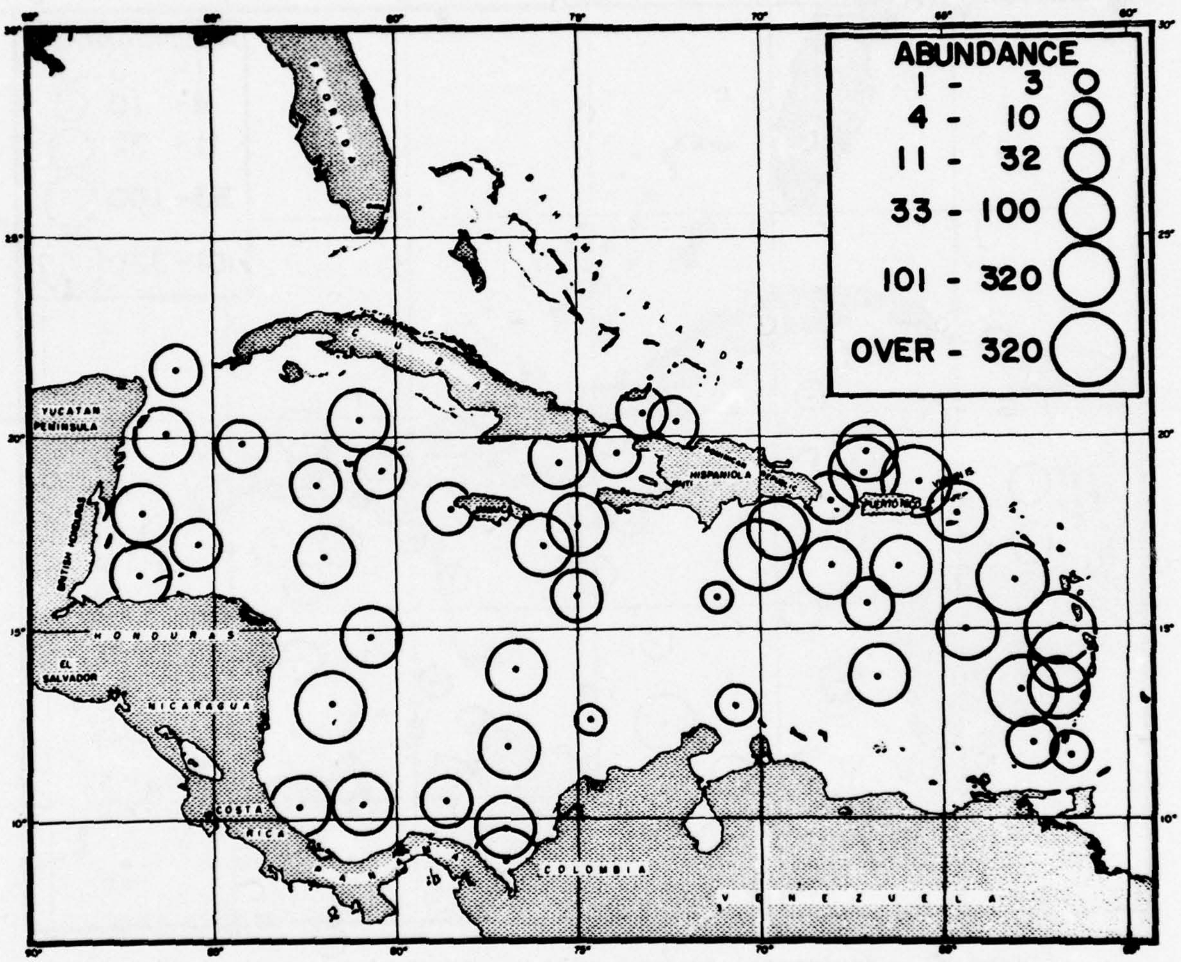

Figure 47. Horizontal distribution of total adult Euthecosomata.

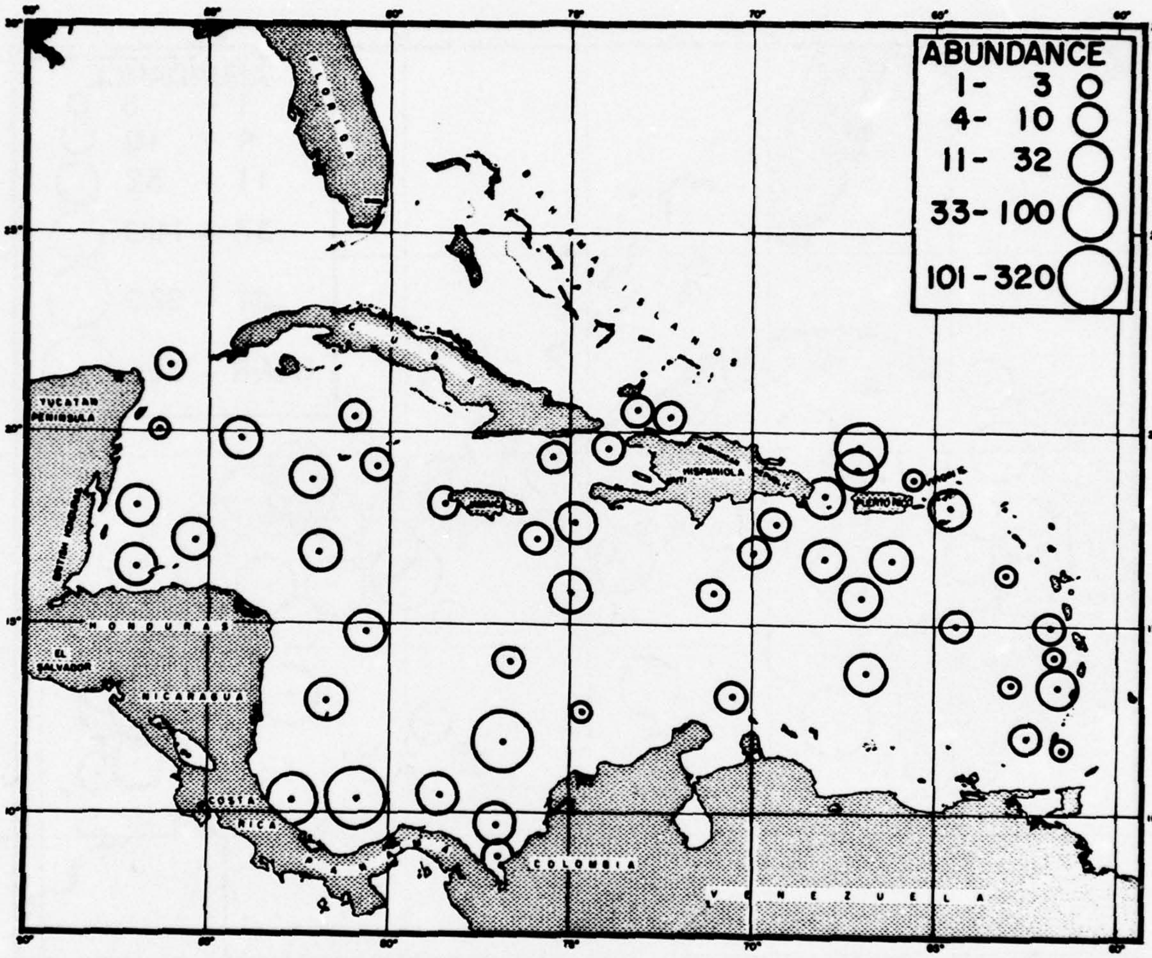

Figure 48. Horizontal distribution of total Pseudothecosomata.

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